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The Effect of Developing Time Upon Distortion in Variable-Area Recording

By GEORGE LEWIN

Variable-area sound recording on film was originally thought to be immune from processing variations. Although the effects of exposure and density upon cross-modulation distortion have long since been recognized and well documented, the significance of developing time is generally overlooked. It is shown that the common practice of adjusting developing time to compensate for exposure errors is not satisfactory. Large errors can never be fully compensated, and small errors are shown to require overcompensation if the optimal print density is to remain unchanged. The need for further study of the effect of changes in the developer itself upon cross-modulation is indicated.

Introduction

When variable area was first proposed as a method of recording sound by photographic means, it was thought that one of its principal advantages would be its immunity from problems of exposure and processing.[1] After all, we were simply photographing the movements of a galvanometer or its equivalent, and the only requirements seemed to be that the film be opaque on one side of the trace and clear on the other side, with a reasonably sharp demarcation between the two. Variations in exposure or processing would have only a minor effect, it was thought, as long as the above requirements were met.

Unfortunately, it was quickly discovered that these requirements were difficult to meet within the limitations of linear film speed on the one hand and the necessary frequency band on the other. In order to record 9000 cycles, a very modest upper limit in these days of "hi-fi," the distance between adjacent peaks on 35mm film is only 0.002 in. If we wish to do the same thing on 16mm film, this distance shrinks to 0.0008 in. This, of course, means that the edge of of the exposed area, which looks so knife-like at 400 cycles, becomes rather fuzzy at 9000 cycles and gives rise to the effect known as "fill-in" or "image spread." This in turn causes partial rectification which introduces severe distortion, generally referred to as cross-modulation, into the reproduction of high frequencies. This is especially noticeable in the "s" and "sh" sounds of speech and is therefore referred to as sibilant distortion or, less elegantly, as "spitting," which has unfortunately become a sort of trademark for improperly processed variable-area recording.

Of course, the reasons for this distortion were eventually determined, and methods for measuring it and determining optimal exposure, processing and printing conditions to minimize it have been in successful use for at least twenty years. The method in general use is known as the "cross-modulation test" and many papers have been published describing its application.[2–5,10,12,14]

All these papers show clearly how, for a given gamma or time of development, each value of negative density has a corresponding optimal print density which will cancel the image spread and reduce the cross-modulation distortion to a minimum. However, no direct reference has been found in the literature regarding the actual effect of developing time upon the cross-modulation. Blaney and Best,[2] in discussing dupe negatives, refer to the fact that a lower negative gamma will cause more image spread and will therefore require a higher print density, but they give no quantitative data for a range of gammas or developing times.

Foster[6] proves by mathematical analysis that, theoretically at least, optimal sharpness can be transferred from negative to positive only when the overall gamma is unity. Dimmick,[7] on the other hand, in the very same issue of the *Journal* apparently refutes this by an elaborate series of practical tests and shows optimal negative and positive gammas which yield an overall of from 2.0 to 4.8. However, both these papers were written prior to the advent of the cross-modulation test and were based upon analysis of single frequencies. Present practice, using fine-grain films, yields overall gammas between 9 and 12 for the soundtrack, but the actual value of negative gamma is not used as a control since it varies relatively little for large changes in developing time. Instead, the developing time itself, or more conveniently, the linear speed of the film through the bath, is used as the control.

Purpose of Investigation

The purpose of this paper is to explore a little more fully the effect of varying the time of development of the negative upon cross-modulation distortion in variable-area recording. The need for this investigation arose when it was noted that we frequently encountered sibilant distortion even though negative and print densities were well within the required limits. It was found that our laboratory—and most other laboratories probably do the same thing—would adjust the time of development to obtain a specified track density whenever the predeveloping test indicated that a given job would not yield the correct density with normal development. It was simply assumed that so long as the specified negative density was obtained, the optimal print density would still be the same as though the negative had been developed normally.

This assumption possibly arises from the fact that a relatively large change in developing time produces a rather small change in gamma when working at the high gammas associated with variable-area recording. For example, in the

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(This paper was received on October 1, 1958.)

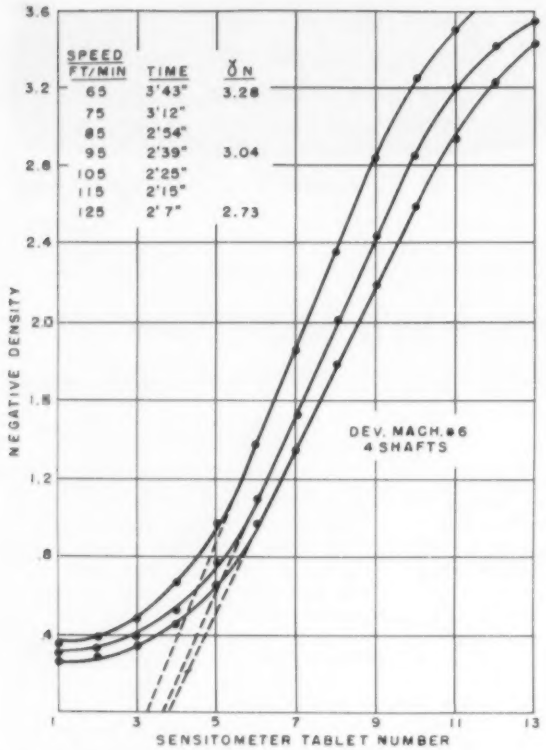

Fig. 1. Negative gammas for various developing times.

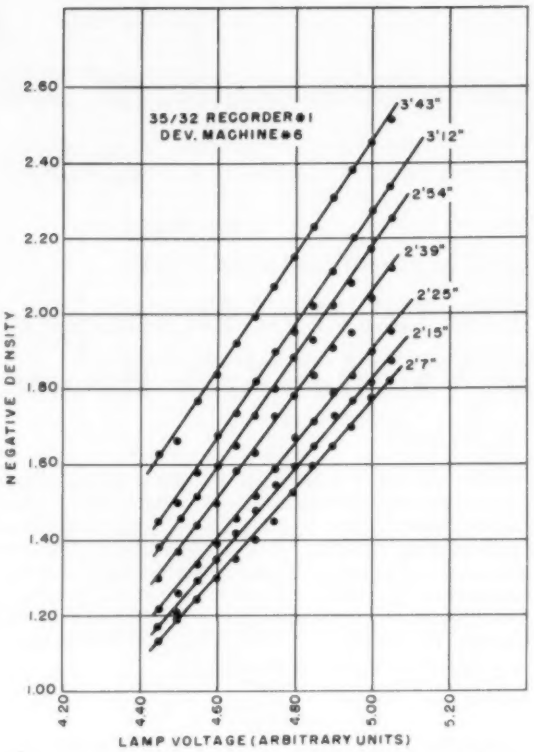

Fig. 2. Lamp voltage vs. negative density for various developing times.

actual tests upon which this paper is based it was found that a 40% increase above normal developing time resulted in only an 8% increase in gamma, which might lead one to suppose that the effect upon image spread and cross-modulation would be equally small. This assumption has proved to be quite in error, at least for 16mm recordings, as this paper will endeavor to show. Since the literature apparently overlooks this subject, a comprehensive series of tests was undertaken in an effort to arrive at a graphical visualization of the range of conditions that are likely to be encountered.

It should be explained here that at the time this investigation was undertaken we were experiencing rather erratic changes in negative exposure which we could not immediately control, and the laboratory attempted to compensate these errors by adjusting the developing time. As explained in a companion paper,[8] we succeeded in correcting this condition, but the data accumulated in the course of the investigation revealed the interesting information which is presented here. Although this information was obtained by deliberately changing exposure conditions to simulate exposure troubles in the recorder, it is quite possible that it is also applicable when there is an apparent change in exposure resulting from variations in developing conditions.

Description of Tests

The tests consisted of seven identical cross-modulation negatives, each covering a full range of negative exposures on one of the 35/32mm recorders which we use for recording the negative for our 16mm release prints. These seven negatives were then developed one after the other at carefully measured developing times covering a range on either side of what was considered "normal" for that day. The negatives were then spliced together and five prints were made covering a range above and below the "normal" print density.

Since 13 exposures were made on each negative, a total of 455 individual cross-modulation sections had to be measured and plotted.

Figure 1 shows the gamma range which was obtained. Only the "normal," maximum and minimum values are shown, since it is obvious that the total spread is rather small despite the relatively wide range of developing times.

Figure 2 shows the actual range of negative densities measured at each cross-modulation exposure for the entire test. Note that the exposure is varied by arbitrary voltage units rather than the more conventional lamp current units. This is explained in the companion paper.[8]

Figure 3 shows a typical plot of cross-modulation measurements on the five prints made from the negative of one particular developing time. A similar plot, of course, was made for each of the other six developing times. These plots are similar to many that have been published in the past, but attention should be drawn to one special precaution which had to be taken because of the fact that different negative developing times were involved. It was necessary to measure the print density corresponding to each different negative because each had a slightly different fog density, as may be seen in Fig. 1. For example, the roll which had a print density of 1.36 at the end which corresponded to the high gamma negative (shown in Fig. 3), was found to read 1.53 at the other end which was printed from the low gamma negative. This means, of course, that in order to obtain a given print density in actual practice, the high-gamma negatives require higher printer points.

Optimal vs. Tolerance Limits

At this point it might be well to anticipate the question which would inevitably be raised by those who have read the previous literature on cross-modulation tests: i.e., "Is it necessary to strive for optimal density when 30 db of cancellation is generally considered sufficient to provide fairly wide tolerances within which acceptable quality can be

obtained?" This may be answered by pointing out that it is really impossible to specify a tolerance which will accommodate all types of voices under all types of conditions. It is well known that optimal cancellation density varies with the frequency of the test signal used, and that different voices are apt to have their sibilant frequencies concentrated in different parts of the spectrum. Our choice of the proper test frequency for 16mm film is based on many tests which seem to indicate that a frequency of 4000 cycles modulated at a 400-cycle rate gives the best correlation between measured results and actual listening to many different recorded voices. Yet we know from experience that we occasionally encounter a "problem" voice or a "problem" condition that results in sibilant distortion. Our experience indicates that the more closely we adhere to a rigid optimum, the less frequently we encounter these problem conditions.

Another reason for using optimal cancellation, rather than 30 db tolerance limits, as the control, is that this tolerance is valid for only one particular negative density. And, as we hope to show in this paper, it is valid for only one particular development condition in both negative and positive baths. As these conditions, especially in the negative bath, are very difficult to maintain with precision, and are even deliberately altered to accommodate exposure variations, it is apparent that this so-called tolerance becomes extremely narrow, or may even disappear.

An interesting reference at this point would be Livadary and Twining,[9] of Columbia Pictures, from whom the following extract is quoted:

"Our experience in the use of the variable-area system as the medium of release has brought to our attention the fact that the means of determining optimal processing conditions, through the use of the modulated high-frequency method as described by Baker and Robinson,[2] does not provide an adequate solution for the problems arising out of the great variety of developing and printing conditions encountered in the various release laboratories. At times, particularly in connection with the re-recording of sharp sibilants, we have had great difficulty in establishing processing conditions for the area tracks that would resolve these sibilants satisfactorily despite the fact that we were able to show cancellations of the order of 45 to 55 db by the modulated high-frequency method."

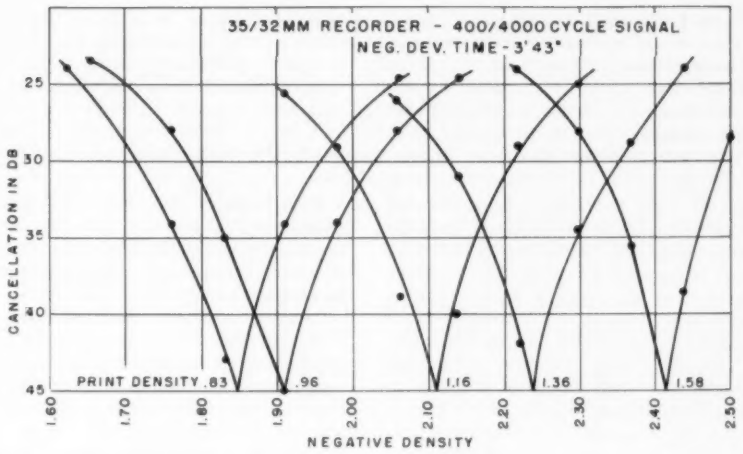

Fig. 3. Cross-modulation cancellation vs. negative density.

This appraisal of the cross-modulation test is perhaps a little too severe in the light of what has been learned since 1945. It is quite likely that the inconsistencies referred to were due partly to an unrealistic choice of test frequency and partly to the effects about to be revealed in this paper.

Figure 4, then, is a summary of all the families of curves representing optimal print density values which correspond to given negative density values for the entire range of developing times. It should be emphasized at once that this represents the conditions for one particular combination of film stocks and developing baths. It shows the effect of varying the developing time of the negative bath while other conditions are kept as constant as possible. The actual values shown will not necessarily be correct for other laboratories, but the general trends are probably typical.

It should also be pointed out that cross-modulation readings become rather erratic at high cancellation values because of imperfect contact in the printing machine. For this reason, as well as

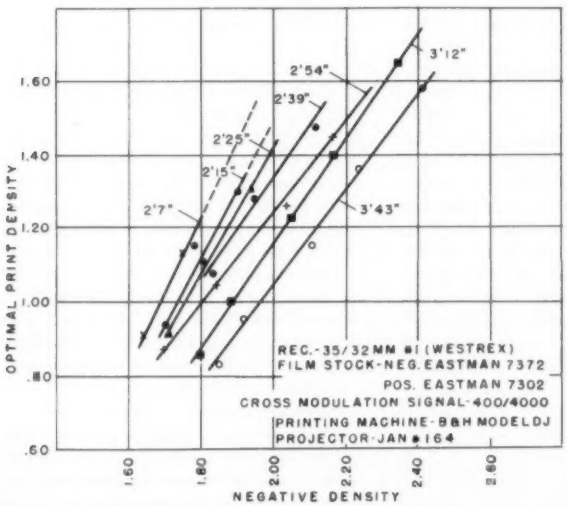

Fig. 4. Negative density vs. optimal print density for various negative developing times.

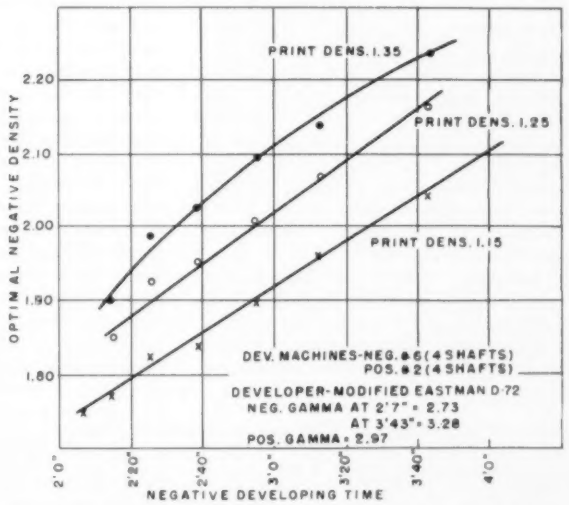

Fig. 5. Optimal negative density vs. negative developing times for various print densities.

Table I. Conditions for Constant Optimal Negative Density.

Lamp voltage	4.64	4.76	4.82	4.90	5.00	5.06	5.13
Devel. time	3′43″	3′12″	2′54″	2′39″	2′25″	2′15″	2′7″
Neg. density	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Print density	0.91	1.01	1.12	1.20	1.27	1.35	1.43

the fact that the optimal points in most cases have to be extrapolated from the preceding data, the points in Fig. 4 do not lie on smooth curves. It is felt, however, that the straight lines as drawn represent logical compromises. Note also that the developing times of 2 min 7 sec and 2 min 15 sec did not provide sufficiently high negative densities to match the higher values of print densities, and their curves were, therefore, extended as shown by the dashed lines to provide the data for some of the discussion that follows.

Analysis of Results

Upon examination of the final results of our test we find that developing time does, indeed, have quite a marked effect upon optimal conditions. For example, in Fig. 4, if we consider 2 min 39 sec as normal and select 1.20 as a standard print density, we find our optimal negative density to be 1.90. But should we encounter a given job which is underexposed to the extent that it must be developed 3 min 43 sec to obtain this negative density, we find that 1.20 is no longer the correct print density. Instead, it is now 0.91. If on the other hand we encounter an overexposed job which requires a development of 2 min 7 sec to obtain a negative of 1.90, the required print density is 1.43.

This indicates that it is really impossible to correct completely for an incorrect exposure — at least in extreme cases. That is, a badly underexposed negative, even if overdeveloped to obtain the correct density, still requires a lower than normal print density. And conversely, an overexposed negative, even if underdeveloped to obtain the correct density, will require a higher than normal density. This can be seen more clearly by referring to Table I, which is derived from Figs. 2 and 4 and shows the values of lamp voltage, time of development and optimal print density that are necessary if the negative density is maintained constant at 1.90.

It should be noted that a print density of 0.91 would probably be noisy and a print density of 1.43 might show signs of high-frequency loss, so that these extreme conditions may be unsatisfactory.

The required correction of print density is reduced by correcting the negative development, but it can never be eliminated unless the negative density is changed, as will be shown later.

From a production standpoint it is desirable to have a single print density which is optimum for all projects. The importance of maintaining constant exposure and development conditions thus becomes very obvious.

Figure 5, which is derived from Fig. 4, shows in somewhat simplified form that, for a given negative developing time and a fixed print density, there is only one negative density and hence only one negative exposure that can yield optimal results. For example, if we wish all our prints to be optimum at a density of 1.25, which is our present standard, then the negative developing time should be 2 min 54 sec and the negative exposure should be such that the negative density comes out 2.00. But, suppose we are underexposed to such an extent that we have to increase the developing time to about 3 min 27 sec to bring the density back to 2.00. We now find the optimal print density can no longer be 1.25 but must instead be reduced to 1.15. If, on the other hand, we are overexposed and find it necessary to reduce the developing time to 2 min 32 sec in order to hold the density down to 2.00, then the optimal print density becomes 1.35.

There is one way out of this dilemma and that is to overdevelop the underexposed job until its density becomes 2.12. Then the optimal print density would remain at our standard of 1.25. Or we can underdevelop the overexposed job to hold its density down to 1.92 and thereby maintain our standard print density. In other words, we can maintain a constant optimal print density by overcompensating the exposure error. This can be seen more clearly by referring to Table II, which, like Table I, is also derived from Figs. 2 and 4 and shows the conditions necessary to maintain a constant optimal print density — in this case 1.20. But note that the permissible range of exposure is much less than in Table I (4.78–5.03 in place of 4.64–5.13). Obviously, we cannot compensate for large errors in exposure.

Table II. Conditions for Constant Optimal Print Density.

Lamp voltage	4.78	4.85	4.87	4.90	4.98	5.01	5.03
Devel. time	3′43″	3′12″	2′54″	2′39″	2′25″	2′15″	2′7″
Neg. density	2.10	2.03	1.97	1.90	1.87	1.84	1.79
Print density	1.20	1.20	1.20	1.20	1.20	1.20	1.20

It is not claimed that this is necessarily a practical procedure for a laboratory to follow, since it presupposes that the developing bath has perfectly predictable performance and that the apparent exposure variations are entirely the fault of the recorder. We know that this is not a realistic supposition. The information is given to emphasize the fact that correcting the developing time merely to achieve constant negative density will not result in a constant optimal print density. It would be necessary to know the degree of overexposure or underexposure by reference to data such as shown in Fig. 2 and then to underdevelop or overdevelop to the degree necessary to achieve the negative densities indicated in Fig. 4 or 5 for the desired optimal print density. This is admittedly impractical, since the apparently incorrect exposure may very well be due partly or entirely to varying conditions in the developing bath itself rather than in the recorder.

Possible Improvements

Having proved, then, that conditions will remain at optimum only if exposure and development conditions never change, the question naturally arises whether such an utopian situation can ever be attained.

Our Laboratory is constantly endeavoring to narrow down such variables as chemical composition, pH factor, replenishment, turbulation and temperature, which contribute to density and gamma variations. But it is giving away no secrets to admit that such variations continue to exist. Every laboratory knows that quality control charts, if conscientiously maintained, will show sharp variations not only from day to day but from hour to hour.

A great need which is indicated, therefore, is an automatic replenishment system and other controls that will detect and correct changes in the developer long before they become great enough to affect appreciably cross-modulation distortion. At the same time, automatic monitoring of the exposure in the recording machine is necessary to ensure that the actual exposure of the film remains constant. This implies more than merely keeping the current in the exposure lamp constant. There are other factors that may affect the exposure, such as sagging of the filament, moisture deposits on the optical surfaces and temperature drifts within the recorder itself. This latter factor is much more serious than ordinarily supposed and is the subject of a separate paper.[8]

Although this paper has pointed out the fallacy of depending upon the cross-modulation tolerance of the film and its processing, there can be no denying that anything which would broaden this tolerance would be of distinct advantage. Alburger[4] has shown, back in 1939, that

tolerances can be broadened considerably by the use of potassium aluminate in the developer. McKie[10] in 1944 published data for 16mm recording which indicated much broader tolerances than we obtain today. Both these authors, however, admit that their data were obtained by somewhat unconventional methods. Alburger used a nonsynchronous printer without sprocket teeth to avoid printer slippage, and McKie used loops of film on a "grindstone" type of reproducer to avoid the admittedly poor 16mm reproducing equipment of that era.

There is ample reason to believe that even today we still suffer considerably from poor contact in printing machines, which affects not only cross-modulation readings but the quality of voice and music as well. There is plenty of room for improvement in printing equipment, especially in 16mm printers.

This paper has concerned itself only with negative exposure and development conditions. There is no reason to suppose that the exposure and development of the print are not subject to similar problems. All these problems must be solved if we are ever to improve the quality of 16mm prints.

One other possible source of unexplained variations is slippage of the film as it goes through friction-drive developing machines. In such machines it is customary to use a tachometer, which actually measures the speed of the drive motor. This tachometer is then calibrated in feet per minute, and it is assumed that the actual developing time is inversely proportional to the speed. This can sometimes lead to considerable error, especially at the higher speeds. A worthwhile improvement would be some sort of device for actually monitoring the speed of the film itself. An even more conclusive indicator would be a timing device actuated by the splice at the beginning of a project to record the actual developing time for that project.

There is also room for improvement in the method of making the cross-modulation test itself. The conventional method used in accumulating the data for this paper is cumbersome and costly in both time and film consumption. It does not lend itself to routine daily testing. Other methods have been proposed which utilize densitometric measurements.[11] These have the advantage of using only a few inches of film and can actually be inserted in the leader of prints as a method of quality control. They have the disadvantage, however, that they do not necessarily reveal contact troubles in the printing machine.

A new concept in cross-modulation was introduced by Herrnfeld[12] in 1948, called "trend control." This utilizes a special oscillator and read-out system which, from a single short test, will indicate whether a print is at optimal density, and if not, will indicate whether it is too light or too dark and by how many printer points.

The latest improvement in cross-modulation testing was described by Wells[13] at the 83rd Convention of the SMPTE in April 1958. This also uses a special oscillator which produces a high-frequency tone pulsed at a 400-cycle rate. The read-out system is such that an optimal density can be established by reading only three points and drawing a straight line, rather than following the involved procedure entailed by the classical method. Moreover, once the slope of this line is determined, it is claimed that subsequently only a single reading is necessary to determine whether a print is at optimal density or, if not, to predict how much correction is required. A further innovation of this system is that the signal can be coded by superimposing a synchronized d-c bias so that there is an audible "dit-dah" or "dah-dit," depending on whether the print is too light or too dark. It is claimed that this test can be made short enough to insert in the leader of a print so that during the actual screening it is possible to check it and, if necessary, to predict the exact amount of correction required.

The reason for mentioning these alternate systems of cross-modulation testing here is to appeal to their advocates to re-examine them in the light of the facts presented in this paper. Any simplification of the procedure necessary to maintain a daily check on recording and processing quality would be a long step forward.

Two other weaknesses of the cross-modulation test should be re-examined by other workers in this field. One is the fact, mentioned earlier in this paper, that the optimal density is a function of the particular test frequency used. The other is that the optimal point is apt to vary for different reproducers, especially if the configuration of the optical system is different. It certainly varies for different types of photocells. The data for this paper were all obtained on the MIL-SPEC projector popularly known as the JAN, which is most widely used by the Armed Forces. It utilizes the infrared-sensitive lead-sulfide cell in contrast to the more common red-sensitive caesium cell. A detailed study of these deficiencies in the cross-modulation test is beyond the immediate scope of this paper. It could best be made by using the various short-cut methods just described.

In closing, it should be re-emphasized that although the developing times and exposures were deliberately changed to obtain the data presented here, we realize that in actual practice we do not always know the exact reason why we have to alter developing time to obtain a given density. It may be that the exposure is wrong. But it is also possible that the bath characteristic is different. Factors such as reciprocity failure between the sensitometer strip and recorder exposure may be involved. This paper has not attempted to investigate the effect upon cross-modulation of controlled changes in bath characteristics. This would be prohibitive by the classical cross-modulation procedure. It should be done by one of the short-cut methods just described, provided we are sure the method is reliable and realistic.

Conclusions

(1) Changes in negative developing time have a much greater effect upon cross-modulation distortion than might be expected from the corresponding change in actual gamma.

(2) Changing the negative developing time to compensate for an error in negative exposure necessitates a change in optimal print density as well. This is undesirable from a practical production standpoint.

(3) The only way to avoid a change in optimal print density is to overcompensate the negative exposure error by still further changing the negative developing time. This presupposes that the behavior of the developer is fully predictable. It also assumes that the printing and developing conditons of the prints are constant and predictable. Undoubtedly these are subject to the same variables as the negatives.

(4) Since the conditions of conclusion (3) are not realistic in actual practice, the only practical conclusion is that quality control must be refined to the point where exposure and processing tolerances can be reduced drastically below the presently accepted values. This will undoubtedly require further research into automatic controls of exposure, processing and printing operations.

Acknowledgments

Thanks are due to Captain Karl T. Weber, Chief of the Laboratory Branch at Army Pictorial Center, for making the Laboratory facilities available for the various tests, and to Jack Byrne and Al Hanna, of the Processing Control Unit, for their assistance in the numerous control problems.

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Discussion

Mr. Lester Bernd (*Cine Service Labs.*): Would it be possible to associate base and fog density to overdevelopment? In other words, could the laboratory get some indication of the degree of overdevelopment by that factor?

Mr. Lewin: I'm not sure if it could be determined that accurately. Perhaps I should have pointed out that in the first slide, where I showed the extreme range of gammas, the fog density does change appreciably. Theoretically, it may be possible to estimate the gamma from the fog density if all other factors are constant, but this is rarely true.

Mr. Bernd: Could you suggest typical values for the base and fog density range in normal practice? That is, if a spot check were made of laboratories throughout the country, what do you think base and fog density ranges would be on variable-area recordings?

Mr. Lewin: I might assume from past experience that the fog density should not exceed about 0.05, above the base density, for normal processing. Usually our fog density does not exceed more than 0.03 or 0.04 above the base density which is normally about 0.24 for E.K. 7372.

Roger Beaudry (*Shelly Films Ltd.*): You noted the use of frequencies of 400 and 4000 on these tests. Have you tried using higher frequencies to see what would happen to this test?

Mr. Lewin: We know that if you use a higher frequency the cancellation point will be higher in density as far as the print is concerned. This has been established time and again and is one of the imperfections of the cross-modulation test. Theoretically, it tells you what density to use to get maximum cancellation, but that cancellation is maximum only at that particular frequency. At higher frequencies, the cancellation density in the print becomes higher, and at lower frequencies, it is lower. The best we can do is to arrive at a compromise. The reason we use 4000 cycles is that listening tests indicate that 4000 cycles is closest to what the average ear accepts as the best cancellation with the types of voices most frequently encountered.

Mr. Beaudry: You are referring primarily to dialogue?

Mr. Lewin: Yes, because this type of distortion is most objectionable in the sibilant sounds of dialogue.

Mr. Beaudry: Would you conclude then that there would be smaller difference in this effect at the higher frequencies than 6000? In other words, the spread between development time and optimum—that would be narrowed down using higher frequencies?

Mr. Lewin: I haven't tried making a full set of tests using the different frequencies because it's really a prohibitive test as far as time and film go. But I can't think of any reason at the moment why using a higher frequency would make this effect any less. One might assume that it would make it even more pronounced. I hope others will make such tests and publicize the results.

John Maurer (*JM Developments*): It has been suggested that the whole range of developing times that you used was considerably lower than the manufacturer's recommended developing time for the type of negative film you were using. I have checked up on some of my own past work and found that we habitually used a higher degree of development, running up to a gamma of about 3.4, for variable-area soundtrack. It would seem that if you produce a negative of a given density, say 2.1, a combination of relatively low exposure and high development will have less image spread on it than if you produce a negative of the same density by higher exposure and lower development. This seems to be the effect which you are investigating. I would like to suggest in no spirit of criticism that this whole thing ought to be re-investigated for a considerably higher range of developing times, because it is, at least theoretically, likely that with high developing time the change of required print density with different developing times for a given negative density would not be as great as it is in the work which you have done here.

Mr. Lewin: That is entirely possible and I agree with you that more work is necessary. The reason for using the developing times that I show here is that we have been using these developing times for the past few years, partly as a result of trying to get out more work in a given amount of time. The laboratory doesn't like an increased developing time; so they call on the Sound Dept. to give them more exposure. And that's the way we gradually arrived at this condition. It's something I've been fighting all the time, but as they say, "You can't fight City Hall."

I would like to add, however, that with our present bath it does seem as though, if we increased developing time, we would start getting into a fog situation and would have to make drastic changes in our developer. Also, the developer we use is not what Eastman might recommend as the correct developer for soundtrack. It is the same developer used to develop the release print. There again it's a matter of economics, to avoid setting aside a separate bath which would be used only part time for sound only. It is more economical to run the sound through the same bath that is used all day long on release prints, even though this makes the sound quality less than optimum.

A Method of Minimizing Exposure Drifts in Film Recorders

By GEORGE LEWIN
and JAMES J. KENNEDY

Serious drifts in exposure have been encountered when making long re-recorded negatives for release printing. These drifts are especially noticeable when using the 35/32mm method where the total recording time may be as high as one hour. Possible causes of this problem are discussed and a method of minimizing it is described.

In our 35/32mm transfer operations, by which we record the negatives used for making the 16mm release prints, we have been continually plagued by rather large drifts in density during the long takes (up to ½ hour) which are typical of this type of recording.* Since a second take is then made in the reverse direction on the same roll of film, the elapsed time between the beginning of the first take and the end of the second is well over a full hour, including the time for rewinding the re-recording print, rethreading, etc. We would frequently encounter extreme differences as high as 0.35 in density. Since these differences were found on two adjacent soundtracks less than ⅛ in. apart on the same piece of film, it was difficult to blame it on the usual scapegoat — the "wet wash laundry" across the street.

Presented on October 24, 1958, at the Society's Convention at Detroit by George Lewin (who read the paper) and James J. Kennedy, Army Pictorial Center, 35-11 35th Ave., Long Island City 1, N. Y.

(This paper was received on October 21, 1958.)

*See the preceding paper in this *Journal*.

Cause of Exposure Drifts in Recording

Numerous tests were undertaken to determine the cause of the drifts and it was finally concluded that they were due to the gradual rise of temperature of the recorder and associated equipment resulting from the long takes. Generally it was found necessary almost imperceptibly to keep advancing the exposure lamp rheostat as the take progressed in order to keep the lamp current constant. We innocently assumed that constant current would necessarily ensure constant exposure. Only after much trial and error did we decide that as the

temperature of the lamp went up, its emission and hence the exposure actually increased if the current were held constant.

With the high gamma necessary for variable-area recording, it is an unfortunate fact that a very slight change in exposure causes a very large change in density. For example, a change of 0.05 amp (which would be considered very small for a lamp operating at 5 amp) will cause a density change of 0.13, which would be considered a large change when operating around a density of 2.00. In other words, a current change of 1% causes a density change of 6.5%, if it is proper to use percentage to express a change in density. Perhaps more pertinent is the fact that a shift of 0.13 in negative density can reduce the cross-modulation cancellation from an optimum of 45 db to a presumably unacceptable value of 29 db. A shift of 0.35, which we have frequently encountered, can reduce the cross-modulation from optimum to a completely unacceptable value of less than 20 db.

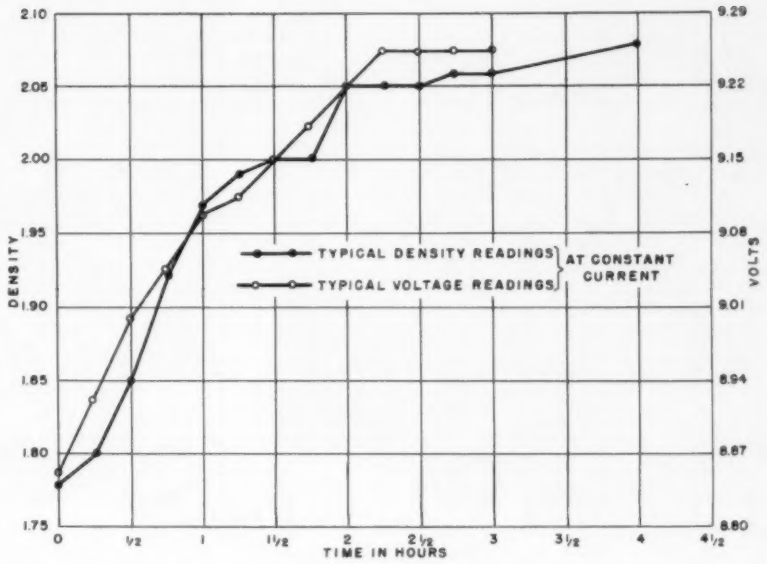

Fig. 1. Similarity of density and lamp voltage variations vs. warm-up time.

Correction of Negative Density Shifts

Having determined the principal cause of density shifts, it remained to find a cure. The simple precaution of thoroughly warming up the equipment before use was already a standard procedure. So was the use of a well-regulated power supply for the exposure lamp. Efforts to provide additional cooling of the lamp were not effective, possibly because, as indicated above, not only the lamp but the entire machine and associated equipment, such as rheostat and ammeter, might be involved. There was even evidence that the ambient room temperature as affected by air-conditioning or lack of it could be contributory factors.

Happily a fairly satisfactory solution was hit upon by using the voltage across the lamp as a control, rather than the current. The theory here was that as the lamp warmed up, its resistance increased and hence more voltage was necessary to maintain constant current. But, since constant current was now known to cause an increase in exposure, it was hoped that if the voltage were kept constant, the current might drop off enough to correct the exposure at least partially. The results of the first few tests were very gratifying. At times the correction was almost perfect and the total density shift was less than 0.03 or 0.04.

Figure 1 shows the results of a test made to determine the relationship between warm-up time, the density of the negative and the actual voltage across the exposure lamp for constant current in the filament. The scale of the voltage axis has purposely been expanded to make the total voltage rise coincide as closely as possible with the total density rise. Thus it becomes immediately apparent that when the density finally stabilizes, the lamp voltage also becomes substantially constant. It is also apparent that the *rate* of rise is very similar for both density and voltage.

This test convinced us that if the voltage rather than the current were held constant, the density would also be constant. Note that it requires more than two hours of warm-up before the density becomes stable. This is quite prohibitive from a production standpoint — especially since it was found that instability would set in even if the lamp were held at reduced stand-by current during short break periods. Since changing to voltage control, it has been found that the density remains quite constant after only a 15-min warm-up.

The voltmeter, incidentally, was obtained by converting the existing ammeter simply by removing the internal shunt. The original scale, which was of the depressed zero type for greater accuracy, was retained without modification so that the graduations are now arbitrary voltage units. Each graduation now, however, causes only about half the density change as before, thus providing much more sensitive control.

With this increased meter sensitivity, voltage fluctuations due to contact resistance changes in the lamp rheostat and various plug connectors became more obvious to the eye, even though they had always been present.

It was decided, therefore, to refine the system further by extending the voltage sampling input of the regulated power supply to the terminals of the recorder itself, rather than leaving it at the output of the regulator, which was located in another room about 30 ft away. The lamp rheostat was eliminated completely. Instead, the voltage control potentiometer of the power supply was extended and mounted adjacent to the recorder so that it became the means of exposure adjustment. This control works in the grid circuit of a vacuum tube and is very smooth and immune from heating effects. A final refinement was to eliminate all plug connectors from the lamp circuit and replace them with solid connections.

The final result is a system wherein the operator adjusts the exposure at the beginning of a job. Thereafter it will remain absolutely stationary at that point without attention unless deliberately readjusted. In fact, we are giving some thought to the idea of eliminating the meter completely and, instead, calibrating the dial of the potentiometer in exposure points.

The above is not intended to infer that the problem of exposure drifts has been completely solved. We recognize that it is merely a fortuitous circumstance that using voltage instead of current control appears largely to offset the variations that are due to temperature drifts. There are bound to be some conditions under which the compensation may be either insufficient or excessive. Some drifts as high as 0.15 in density have been observed since the system has been in operation, but on the average they run from 0.04 to 0.08. The extreme cases of 0.35 or so which used to be common have never recurred.

Further Improvements Needed

There are other factors which may contribute to exposure drifts besides the one described in this paper. There

is always the possibility of the lamp filament sagging and causing a reduction in exposure despite the precautions outlined above. Also, lamps blacken with age, resulting in a loss of exposure. Moisture has been known to condense on optical surfaces as a result of sudden temperature and humidity changes and cause reduction of exposure. A method for the detection of exposure changes employed many years ago with some success in connection with variable-density recording was to measure the light just before it reached the film, using a small prism to reflect the light into a photocell and measuring it with a sensitive microammeter. This is not practical for variable-area recording because the light flux is so much lower. However, with modern techniques using a light chopper or photomultiplier and stabilized amplifier, it should be possible to develop a practical system.

Conclusions

(1) Constant current in an exposure lamp does not ensure constant exposure during long recordings since the gradual rise in temperature of the lamp causes both its resistance and its emission to drift upward. This drift continues for at least two hours in typical applications.

(2) The resultant upward drift in exposure can be drastically reduced by using a voltmeter rather than an ammeter for setting the exposure.

(3) A regulated power supply is essential to provide a basic source of constant voltage.

(4) Even with constant voltage, erratic current fluctuations are apt to occur as a result of contact resistance variations in the rheostat and plug connectors. These should be eliminated completely and replaced by solid connections.

(5) The voltage control potentiometer of the regulated power supply should be extended to the recorder itself and used to control the voltage on the exposure lamp.

Large-Area Negative Printing

By W. E. POHL

The background of large-area negative photography and processing for use at Technicolor Corp. is reviewed, together with techniques for producing anamorphosed and de-anamorphosed types of prints from such negatives.

WHEN LARGE-SCREEN techniques were first introduced, it became apparent that improvements were needed in print quality with particular reference to grain and definition for proper presentation of a satisfactory image on large screens. One of the ways in which a worthwhile improvement can be obtained is through the use of large-area negatives from which 35mm release prints can be prepared. Technicolor has been making prints from several types of large-area negative, and some of the techniques involved in producing prints are described below.

Higgins, Lamberts and Purdy of the Eastman Kodak Company have reported on the effect of introducing the print-down stage at various points in a duplicating procedure.* The conclusion was reached in this paper that almost all of the effect on definition was achieved in the Eastman Color Negative-Positive system if the negative to positive area ratio could be 2:1. Some additional help was found to be obtained on apparent graininess with larger ratios, but this is a diminishing effect, most of it having been achieved at the 2:1 ratio. This work, reported by Dr. Higgins, substantiated the importance to print quality found in the first of the large-area negative procedures which was developed by Technicolor and Paramount and called VistaVision.

There was considerable need for a corresponding improvement in prints from anamorphosed negative. Although there are many possibilities which might be considered in this field, the two which have been reduced to commercial practice are Metro Camera 65, developed by Metro-Goldwyn-Mayer, which was used on *Raintree County*, and the system of Technirama prints introduced by Technicolor. The system used by Technicolor to produce Technirama prints was originally engineered to utilize that portion of a double-frame negative not occupied by a normal soundtrack so that contact prints could be made and a normal soundtrack also used in the regular track area. Since normal release prints were to be produced for projection with the 2:1 de-anamorphoser with which many theaters are equipped, the above specifications for the available negative area automatically set the anamorphosing factor for original photography at 1.5, which in turn fixes the printer squeeze factor at 1.33.

The Technirama camera lens anamorphic attachments were obtained from N.V. Optische Industrie, De Oude Delft, who designed the Delrama reflection system outlined in Fig. 1.† Tests of the anamorphic attachment and proposed prime lens disclosed that there was a linear relationship between the prime lens focal distance and the focus required for the anamorphosing unit. This permitted the gearing together of the two units for focusing purposes so that the complete focus adjustment can be made with a single selsyn motor system on a camera which drives the prime lens, which is in turn geared to the anamorphic lens, as shown in Fig. 2.

In this way, it was possible to supply a single remote-control focusing system. The camera is equipped with 50mm, 75mm, 100mm and 135mm lenses and a

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*G. C. Higgins, R. L. Lamberts and R. A. Purdy, "The effect on definition of the stage at which reduction is performed in reduction-printing processes," *Jour. SMPTE, 65:* 31–35, Jan. 1956.

†A. Bouwers and B. S. Blaisse, "Anamorphic mirror systems," *Jour. SMPTE, 65:* 146–150, Mar. 1956. (Reprinted from *Optica Acta, 2:* 36–42, Apr. 1955.)

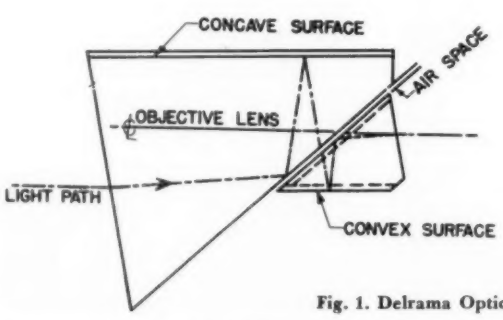

Fig. 1. Delrama Optical System schematic diagram.

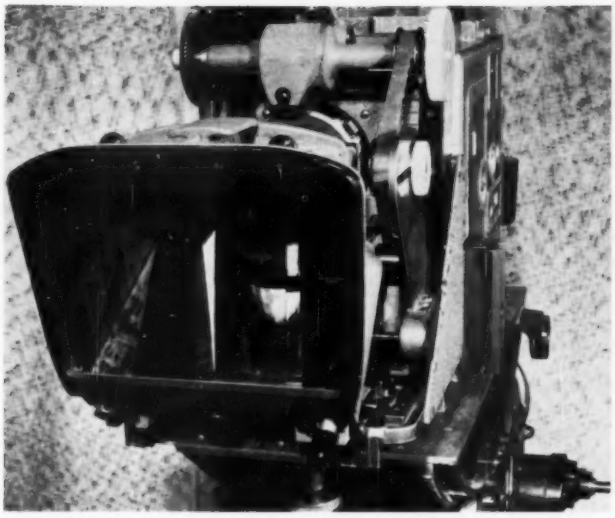

Fig. 2. The Delrama Camera Anamorphoser mounted on a Technirama Camera.

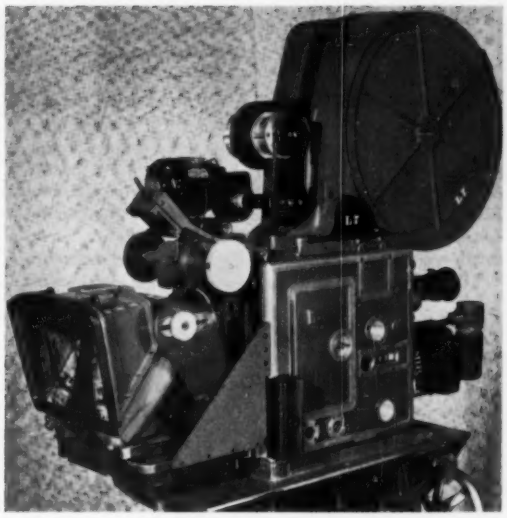

Fig. 3. The Technirama Camera with the camera anamorphoser and 2000-ft magazine in place.

gear shift is provided so that the single anamorphic unit will work with any of these lenses and quick substitution of the prime lens can be effected. Because double-frame negative cuts the playing time for a 1000-ft roll in half, it became desirable to furnish negative in 2000-ft lengths for the Technirama camera. The 2000-ft magazine with take-up and feed sides back to back was, therefore, devised (Fig. 3). To avoid the complications of attempting to drive through the cover of one of the magazines, the drive is carried up in the area between the take-up and feed sections. This makes for easy operation and quick threading.

After exposure, the Technirama negative is processed in the usual Eastman Color Negative procedure but in the Technicolor Laboratory with a modification for optimum quality on optical printing. An anamorphic lens on the printer with a 1.33 squeeze completes the anamorphosing of the image to obtain a release print in the normal 35mm frame, which is suitable for anamorphic projection using the same 2X unsqueezing equipment with which many theaters throughout the world are equipped. We have obtained very good printer lenses from Panavision and from Taylor, Taylor and Hobson.

It is also possible to make an extraction for flat projection using a de-anamorphoser on the printer to remove the 1.5 squeeze imposed by the camera lens, at the same time adjusting the image size so that a 1.85 aspect ratio section can be printed from the central section of the negative image. This has the effect of discarding the negative information that is outside the 1.85 aspect ratio area. In this way, an excellent flat print can be obtained. Similarly, 16mm reduction matrices can be printed for the Technicolor imbibition process for making normal squeeze 16mm prints on unsqueezed versions corresponding to the unsqueezed 35mm version.

Much of the initial work on the development of Technirama was carried on at Technicolor Ltd. in England under the direction of George Gunn of that organization.

Very similar considerations apply to the making of prints from partially squeezed 65mm negative made from the photographic system used by Metro-Goldwyn-Mayer on *Raintree County*. Such negative is processed by Technicolor with the same process modifications that are required for optimum optical printing. As in the case of Technirama prints, a printer lens is required for matrix printing to bring the anamorphic ratio from the 1.25 squeeze introduced by the camera lens to the 2.0 squeeze required in the prints so that they may be projected in theaters equipped with ordinary 2X de-anamorphosers. The printer anamorphoser was supplied by Panavision. Although we have not yet made flat version prints in this system, it will be obvious that they can be prepared by the same principles used to supply unsqueezed prints from Technirama negative.

Another modification of the application of large-area negative to the production of 35mm release prints is exemplified by the system used by Michael Todd Productions in producing *Around the World in Eighty Days*. Here a 65mm negative was photographed with conventional spherical optics and has been used with special anamorphic printing lenses to produce anamorphosed 35mm Technicolor prints for projection both through a 2.0 de-anamorphoser and a 1.56 de-anamorphoser. The 1.56 de-anamorphoser is particularly useful in maintaining all of the information that was photographed on the negative and has been widely used in Europe. The 2.0 anamorphosed prints are, of course, suitable for use in the many theaters equipped with a 2.0 de-anamorphoser.

We believe that the use of the Technicolor imbibition printing method for making prints from large-area negatives offers unique advantages, since prints from the original negative can be made for any of the commonly used projection systems. This avoids the quality losses which are inevitable when a duplicate negative is made and is substantially important for prints for showing in Europe, as the many complaints which have been encountered with prints made from dupes are thus easily avoided.

In the presentation of pictures the highest quality print is often needed for a roadshow presentation and considerable success has been achieved through the use of 70mm release prints and dual or convertible projectors for showing such prints. Technicolor has made many of these prints by direct contact printing from 65mm negative. Another interesting possibility in the use of 70mm release prints is that of making them from 8-perforation negative, embodying a squeeze as for Technirama or as in VistaVision, which uses spherical optics in photography. This transfer of information from an 8-perforation negative frame to a 70mm print of necessity involves optical printing, which may include anamorphosing or de-anamorphosing as may be desired.

Ed. Note: The Convention presentation included a projected demonstration of 35mm imbibition prints from 65mm negative reel 10B of *Raintree County* and a 70mm color positive print made from Technirama negative.

Increased Depth of Field for Motion-Picture Photography

By SIDNEY ZIPSER

The development of wider screens and larger camera apertures has brought about a need for increased depth of field. A practical comparison is made of lens focal lengths commonly used. Depths of field are shown in relation to focal distances and *f*-stops. An accurately calibrated camera aperture which pivots on its vertical center is proposed as one means of increasing the depth of field across the picture area.

During the past several years, as projection screens have become wider, efforts have been directed toward maintaining adequate definition which would keep pace with the expanding size of screens. The depth of field (depth of focus) of the camera lens required to bring both near and far objects into view with reasonable sharpness is one aspect of overall definition.

Unless the script calls for wrapping the scenery around the audience, or for such novelties as a dizzy ride on a roller coaster, the usual photography of people, exteriors and sets, especially when considered in relation to the economics of set design and lighting, may be best accomplished by the use of lenses with longer focal length and less inclusive emergence angles, which means a loss in depth of field. On the other hand, the very nature of the wide screen requires staging and editing techniques which call for greater depth.

Writers, directors and cameramen have never been satisfied with the limitations of lens optics, even for the Academy aperture. Television productions also suffer, for in action closer to the camera there is even less depth of field.

Numerous methods have been proposed for achieving an illusory "universal focus." Most of these proposed methods would, in practice, sacrifice critical definition or would require the use of complicated, time-consuming and restrictive devices. None of the proposed methods has been widely used.

If optical laws rule out a true universal focus, a practical compromise might be made by considering specific compositions which are widely used. For example, there are endless possibilities of staging a scene with two people, the boy and the girl, or the hero and the villain. On a wide screen this is a natural for composition, but the dramatic impact of playing the scene in depth with an illusion of the third dimension is limited by the capacity of the lens to maintain sharpness in the desired range.

For a lens of any given focal length, the depth of field varies with the focal distance and the *f*-stop. The lenses commonly used on motion-picture cameras, vary from 25mm to 100mm in focal length and have peculiar differences which may best be shown graphically. For simplicity and comparative purposes it may be assumed that the Depth of Focus tables based on a circle of confusion of $\frac{1}{500}$ in., commonly used by cameramen, are satisfactory, and such contributory items as relative negative size, anamorphics, lens aberrations, magnification, lighting contrast, etc., may be ignored. It should be noted that this depth of field is based on a theoretical point in a diminishing sharpness scale and its limits are frequently stretched.

Figure 1 is a plot of the hyperfocal distances of the various lenses at stop *f*/8 which are a frequent guide in exterior color photography. At these focal distances, the respective lenses will be sharp to infinity and halfway forward to the camera. It will be noted that the shorter focal-length lenses from 25mm to 50mm have remarkable depth under these conditions. This is a clue to shooting demonstration reels. The longer focal-length lenses lose the capacity to carry a foreground object as sharp as an object in the background.

Figure 2 shows the depth of field of the different lenses when focused on 10 ft, an arbitrary distance for a two-shot. It can be seen that the 50mm lens marks a crucial turning point. Shorter focal-length lenses, such as the 35mm and 40mm, most frequently used for the Academy aperture, have very good depth, especially when stopped down. The 25mm has exceptionally good depth but it has too wide an angle for some of the newer systems. On the other hand, the 75mm and 100mm lenses have very little depth at 10 ft, even when stopped down to *f*/8.

Problem of Depth of Field

Depth of field becomes a more serious problem when photographing interiors

Presented on April 22, 1958, at the Society's Convention in Los Angeles by Sidney Zipser, (formerly of Technicolor Corp.), Free-lance Cameraman and Consulting Engineer, 4245 Troost Ave., North Hollywood, Calif.
(This paper was received on July 14, 1958.)

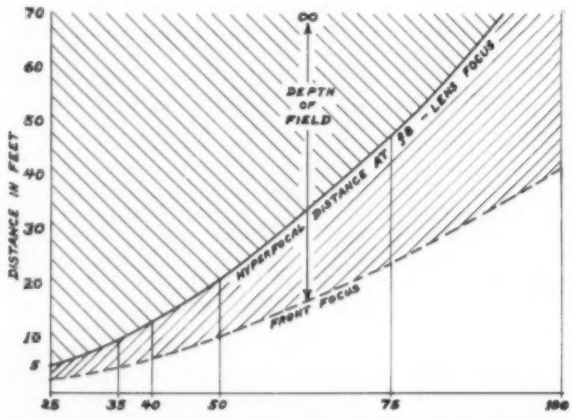

Fig. 1. Depth of field of motion-picture lenses at f/8 and hyperfocal distances. (Lens focal length shown in mm.)

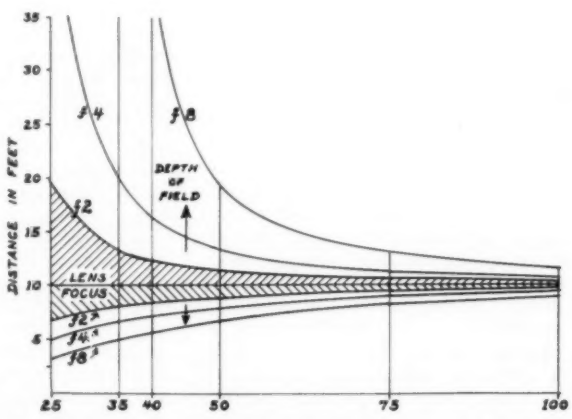

Fig. 2. Depth of field of motion-picture lenses at 10-ft foci and various f-stops. (Lens focal length in mm.)

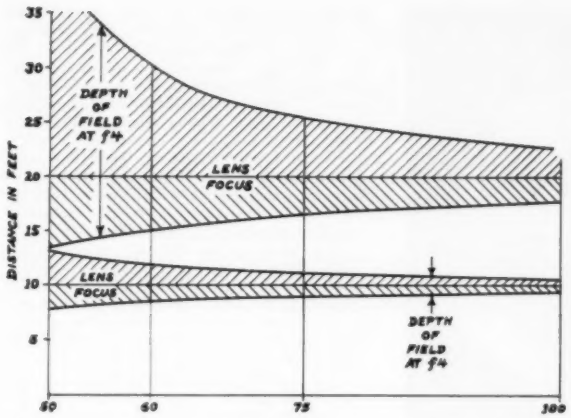

Fig. 3. Depth of field of motion-picture lenses at 10 ft and 20 ft and f/4. (Lens focal length in mm.)

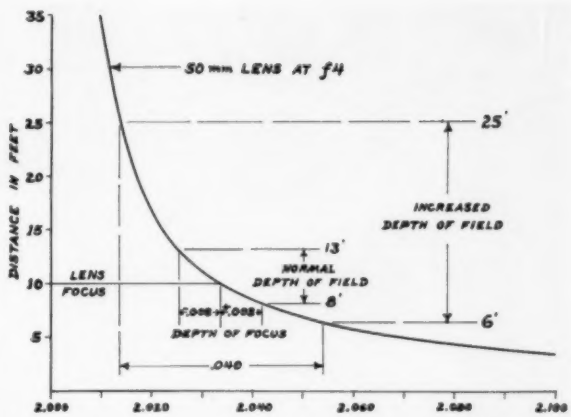

Fig. 4. Relation of depth of field to depth of focus for a 50mm lens. (Back focus — lens or film displacement in in.)

on color film with the larger camera apertures which require longer focal-length lenses for equivalent photographic angles. Lighting costs are high and 800 ft at $f/4$ is a common limit. The upper portion of Fig. 3 shows that a 50mm lens set at 20 ft and $f/4$ would carry focus from about 13 ft to 40 ft, which usually is adequate for full-figure shots of people in which the background must be sharp. If a 75mm lens were used for the same negative size and magnification, that is, about 30 ft away from the main persons, the depth of field would be comparable but the background would appear closer to the people on the screen.

The lower curves of Fig. 3 show the limited depth with all these lenses at closer distances, in this case 10 ft. In other words, if a medium shot is photographed on one side of the picture area, objects appreciably farther back are out of focus.

A similar problem with professional still cameras has been solved in many cases by swinging the film holder, the lens board, or both. If the lens or the film plane is twisted horizontally so that they are no longer parallel, the focal distances can be varied across the negative, and it is possible to have a medium shot on one side of the screen and a full figure on the other, both sharp.

Obviously, such a feature would be desirable in a motion-picture camera. Swinging the lens appears to be the simplest maneuver and it has been tried on different occasions, but it is complicated by a variety of interchangeable lenses, focusing devices, movement of actors and the camera, and lack of calibration. Swinging the film plane when the film is traveling 90 ft or more a minute and, at the same time, to maintain precise registration and steadiness seems a bit overwhelming, offhand.

But if we want a camera that can be used with no handicaps on regular production, and which offers all the usual features plus a reliable fast-working system for increased depth across the picture area when required, there is this possibility: to pivot the film aperture on its vertical center. This would mean that the focus calibration of all of the lenses would always be accurate for the center of the field, and the pivoting itself could be calibrated.

Pivoting the film aperture would most likely require pivoting the whole film movement and shutter as well as the rack-over device for direct viewing. In a camera with horizontal travel of film as required by the VistaVision or Technirama process, this whole pivoting assembly could move inside a fixed camera shell, the movement drive being through a hollow shaft which would also be the pivot center of the film plane. The lens mount, finder, magazine and matte box would all be fixed. The size and weight of the whole camera and blimp (if required) would not be appreciably increased, and with the aperture pivot set at zero, the camera would be normal in every respect and possibly improved by the new design.

This was the original proposal but other variations are possible. A Mitchell camera might have the camera box, rack-over and magazine pivoted in relation to a fixed lens mount. The Technicolor and VistaVision type rack-up could also be applied to vertically traveling films so that a horizontal rack-over and pivoting aperture could be included in a fixed shell. A 65mm camera would be especially benefited by the increased depth of field which the pivoting aperture would make possible.

Based on Technicolor's interest in exploring every possibility of increasing the overall definition of the motion-picture process, a mock-up of a pivoting aperture camera was constructed. The quickest and least expensive way to demonstrate the idea was to pivot a VistaVision camera on an old 3-D convergence base in relation to a fixed lens mount. While the results were successful, this device is hardly adequate for production. Technicolor is not contemplating building a practical version of it, as far as I know.

This device differs from similar methods in that the equipment can be calibrated, which is an almost essential requirement if the focal plane is to be varied during a scene. Eye-focusing with two variables would be rather awkward and impractical for motion-picture production.

There is a definite mathematical relationship between the placement of objects in front of a camera and the position of the film plane relative to the lens, even when pivoted. This can be seen in Fig. 4. If a 50mm lens at $f/4$ is focused at 10 ft, its normal depth of field will be from 8 to 13 ft, as shown vertically. Its depth of focus, and this is more or less the true meaning of that term, is the equivalent displacement of the image plane with respect to the lens which is ± 0.008 in. at $f/4$ and is shown horizontally.

A photograph of two men, one 6 ft from the camera and the other 25 ft away, each one-fourth of the way inside the picture on opposite sides could be a very effective shot if both figures were sharp, but such a picture is impossible with existing cameras using a 50mm lens at $f/4$. However, if the aperture were pivoted for the required film displacement of 0.040 (or less if the normal depth of field were used), and the focus set at 10 ft, it would be possible. Simplified calibrations, measurements and charts would make it practical.

Figures 5 and 6 are reproduced from the original tests photographed on 35mm Eastman Color Negative Film, Type 5248, with a Technicolor Lazy-8 camera (modified) and a 50mm lens at $f/2.8$ with a 400-ft light level. Figure 5 illustrates normal photography and Fig. 6 shows what can be accomplished by merely pivoting the camera aperture relative to the lens. The increased depth

Fig. 5. Normal photography with a 50mm lens at f/2.8.

Fig. 6. Pivoting aperture photography with a 50mm lens at f/2.8.

of field on the figures is equivalent to a stop of $f/16$ which would require 32 times as much light or 12,800 ft.

Conclusion

The pivoting aperture camera, while not simple or inexpensive, would provide a new and desirable flexibility in staging some motion-picture scenes. The dramatic possibilities are considerable, even within the obvious limitations.

Lighting time and costs could be effectively lowered for many scenes by merely pivoting the aperture instead of using higher light levels when scenes of this scope are required. Further economies would also result from the combined close-up and long-shot staging which would reduce the number of scenes required for a given sequence.

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Discussion

Lionel H. Wheeler (Colorvision, Inc.): I noticed that the demonstration and the paper are based on the fixed composition of the picture — in other words one man is close up on one side of the screen and the other is in the background on the other side. Have any experiments been made in following focus?

Mr. Zipser: We haven't gone that far yet because this is a crude mock-up. It would be possible both to change the lens focus and to pivot the aperture during a scene. However, no changes would be required if the far man walked toward the closer man across the screen, confining himself to the focal plane plus or minus the usual depth of field at each distance.

As focus changes are usually made to predetermined marks, it is conceivable that the lens focus and pivoting aperture could be ganged and servo-controlled by one man. The calibration would be two-dimensional: parallel lines for focal distances, intersected by divisions of the lens angles. The control lever could be twisted to pivot the aperture and slid forward or back to change focus, the operator referring only to the actors and the usual marks on the floor.

John R. Moore (Panavision, Inc.): On your demonstration reel, was the focus split as in normal photography, and was the focus at the same point after you pivoted the aperture? If not, which way did you shift it?

Mr. Zipser: In the normally photographed scenes, the focus was set as far forward as possible, keeping the back man sharp and using the usual depth-of-focus tables. In the pivoted aperture scenes, the focus was set by reference to a chart similar to Fig. 4. I measured the distance to each of the two men who had been placed a quarter of the way inside the aperture and drew vertical lines on the chart corresponding to the distances of these men. Now, a vertical line midway between these two would indicate the actual lens focus. The separation of the two lines, measured in thousandths on the chart, would indicate the aperture displacement for half a field width. A slide-rule affair could be worked out to make this fast and simple, especially if focus changes were involved.

Mr. Moore: What would you have anticipated if you had had a man in the middle of the frame?

Mr. Zipser: He would have been sharp if he had been placed at a distance corresponding to the lens focus, or within the normal depth of field at that focus. Mentioned in the paper was "obvious limitations," meaning those you would have with the swing-back of a view camera. That is, you couldn't have a man in the center sharp if he were not in the predetermined zone of focus. Nor could you have a close-up on each side and a distant man in the center, all sharp. I make no claim for universal focus, but want only to point out that greater depth of field for the basic widely used two-shot would increase the flexibility of staging and photography considerably. Other variations, such as focus changing or photographing a whole row of chorus girls or soldiers at an angle, are also possible.

Franklin D. Hood (Tektronix, Inc.): Would you accomplish the same result if you used a glass wedge behind the lens? The varying thickness of glass should change the focal plane the same way without pivoting the aperture.

Mr. Zipser: I tried this without much success. It would certainly be simpler and cheaper, but a single piece of glass varying from about $\frac{1}{4}$ to $\frac{1}{32}$ of an inch across the field evidently introduced too many distortions and aberrations to give satisfactory definition. There may be a better optical way of doing this. However, the pivoting aperture could be changed during a scene, which is advantageous, and there would be no glass close to the film which would have to be quite clean at all times.

H. E. Burson, Jr. (Hughes Aircraft Co.): You mentioned the curved plane of focus when the aperture was pivoted. Which way does the plane curve relative to the camera?

Mr. Zipser: I believe the curve swings toward the camera. It can be accurately determined by referring to Fig. 4. This curved plane, of course, refers to object distances in front of the camera. The film plane would be flat.

Mr. Burson: Does the curve increase as the angle of the aperture is increased?

Mr. Zipser: Yes, it does. In Fig. 4, if the aperture is displaced 0.040 across its width as indicated, and the lens focus set for 10 ft in the center of the field, one side will focus at 25 ft and the other at 6 ft. Now, if the lens focus is left at 10 ft, and the aperture angle increased, the 0.040 displacement will also be increased in equal increments horizontally, each side of center. This will increase the depth of field as the curve shows. As the focus across the film plane is proportional to the horizontal displacement shown in Fig. 4, the curvature you speak of would obviously increase with the aperture angle or horizontal displacement.

Photography of Very Early States of Nuclear Explosions

By HAROLD E. EDGERTON

A method of photographing the early phases of atomic explosions by the use of the Faraday shutter is described. A 10-ft focal length Newtonian telescope was used to give a large image with the camera at approximately 7 miles from the explosion. Two photographs of very early phases of atomic explosions in metal shelters are shown. A 1-μsec Rapatronic (Faraday) shutter was triggered when the light intensity reached a value where a photograph would be exposed.

THE PHOTOGRAPHY of atomic explosions, particularly the early phases, has been a serious technical problem because of the very large range of light intensity, the very short duration of the initial light, and the high velocity of the early phenomena. Furthermore, the light values of a particular explosion are quite often of unknown intensity. In fact, the determination of the intensity and its duration by photographic means is one of the goals of the effort. Another objective is to find out as much as possible about the way in which the explosion occurs.

This paper reports one method of obtaining short-exposure single photographs of the early phases of an explosion.

A contribution submitted on October 28, 1958, by Harold E. Edgerton, Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15; and Massachusetts Institute of Technology, Cambridge, Mass.

Optical Arrangement

Because of the dangers of damage to equipment by radiation and shockwave action, it was necessary to place the equipment several miles away from the explosion. The camera, a conventional 35mm type, was located at the top level of a 75-ft tower.

A Newtonian-type telescope with a 10-ft focal length was used as the primary lens. The image from the telescope was then magnified to about twice its size by a 2-in. focal length relay lens. The optical arrangement is shown in Fig. 1.

Alignment of the telescope and focusing were complicated by the mechanical deflection and vibration of the tower itself. A satisfactory method of focusing was evolved by the use of a 1000-w lamp placed at the subject position. A vibration pattern appeared on the ground-glass image of the camera, and the focus was adjusted until the lines of the pattern were minimized. Figure 2 shows a typical vibration pattern made with a time exposure, with the camera in focus. A second light on the roof of the bomb cab caused the upper pattern which is, of course, the same as that caused by the main focusing lamp.

Figure 3 shows a similar, but longer, time exposure including a flash photo exposed by an electronic flashlamp in the

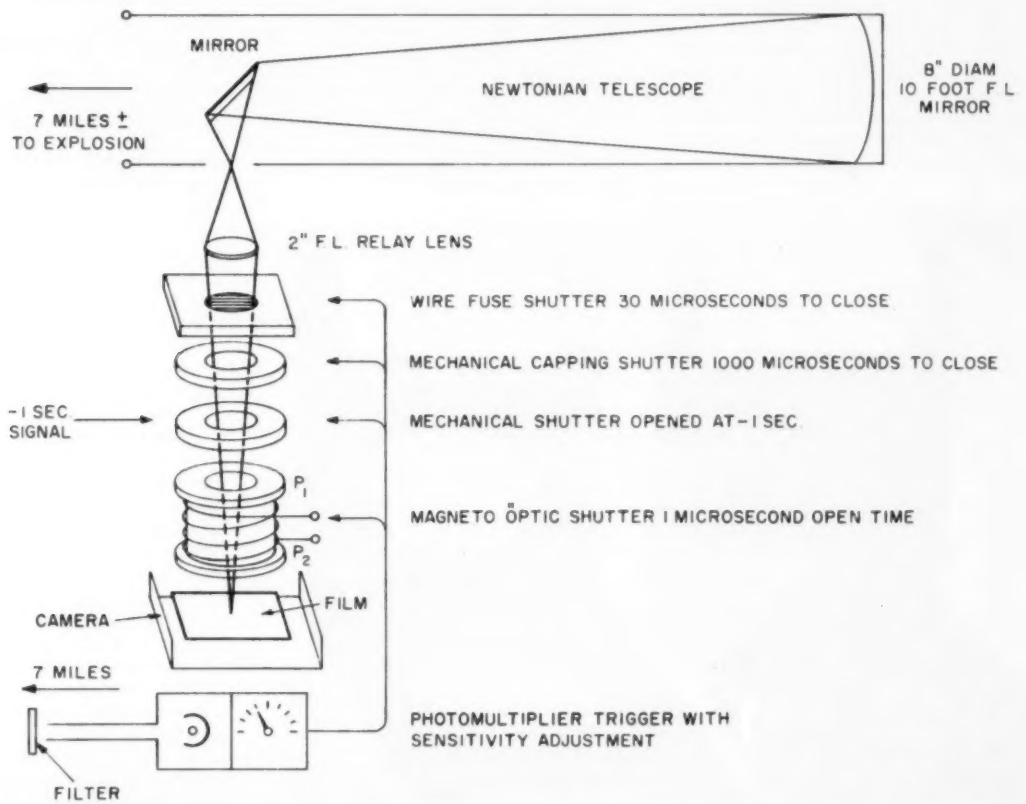

Fig. 1. Optical arrangement of equipment used for photographing early phases of an atomic explosion.

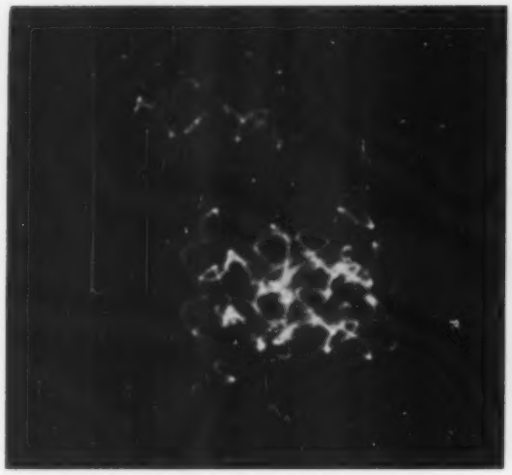

Fig. 2. Typical vibration pattern of image, made with a time exposure and the camera in focus.

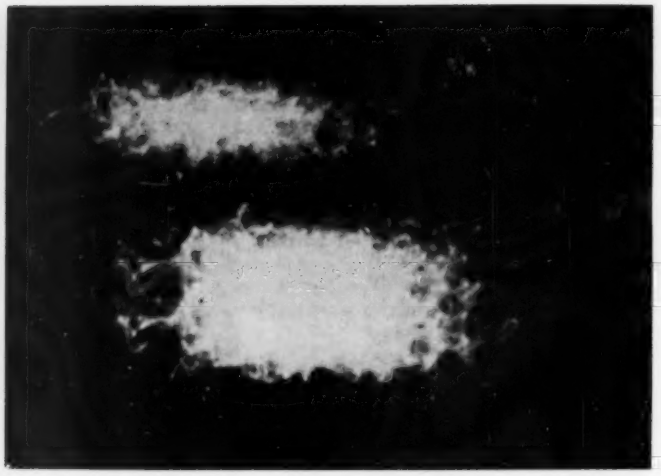

Fig. 3. Vibration pattern of image, made with a longer time exposure than in Fig. 2 and with flash.

bomb house. Notice that the casements of the windows are clearly shown. These were about an inch in dimension. The total excursion of the image was about 15 ft due to wind-created vibration of the camera tower.

Shutters

The Rapatronic[1,2] magnetooptic shutter was used as the 1-μsec element for exposing the photograph. A coil with five turns around a 1-in. glass element of 1-in. length produced a 1-μsec open time when a 0.1-μf capacitor charged to 30 kv was pulsed into the coil by a series three electrode gap switch. A resistor was used to damp the electrical oscillations of the circuit. The magnetooptic shutter was placed almost in contact with the film as shown in Fig. 1. One of the polarizers was adjustable so that the shutter could be opened for visual focusing with all the glass parts of the optics in place.

An open-to-closed ratio of a good magnetooptic shutter is about 10,000, and therefore bright sunlight can slightly fog through a "closed" shutter. The light from an atomic explosion, which can be up to 100 times as bright as sunlight, obviously could cause severe damage if the magnetooptic shutter alone were used. Therefore, two additional shutters were employed — a "fuse wire" shutter[3] with a closing time of 30 to 100 μsec, and a mechanical capping shutter with an operation time of 0.002 sec. Figure 4 shows the appearance of the fuse wire shutter in its open and closed states.

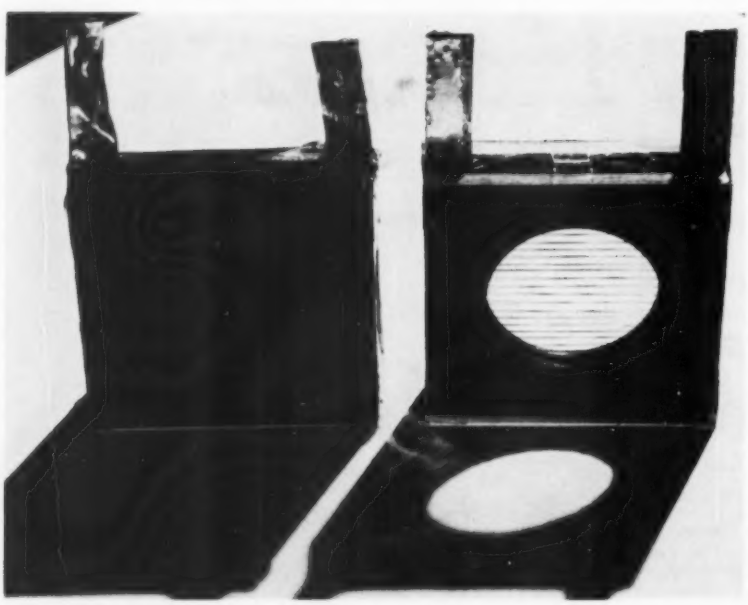

Fig. 4. Fuse wire shutter in its open and closed states.

Triggering

A mechanical shutter, remotely operated by a solenoid, was opened 1 sec before the atomic explosion.

When the light from the explosion reached a value where proper exposure would result, a photomultiplier tube triggered thyratron circuits to operate the following devices:

(a) mechanical shutter that *closed* in 2 msec;

(b) the fuse wire shutter that *closed* in 30 μsec;

(c) the magnetooptic shutter which *opened* and *closed* in 1 μsec.

It is possible for the photomultiplier to trigger the magnetooptic shutter at light levels far below those capable of producing a photographic image. Therefore, it was necessary to adjust the triggering intensity to a satisfactory level before the shot. It should be pointed out that such a calibration is vitally necessary in photography of nuclear explosions, since there is only one chance for each test. For this particular set of experiments, an EG&G "Sunflash" flash unit, which produces a peak flash of about 10^8 beam candlepower seconds, was used. A 30-in. diameter reflector with an FT-17[4] flashtube (similar to the General Electric FT-623) operated from 1000 μf at 4 kv. The reflector was placed at a distance such that the image of the reflector on the film would occupy about the same area as an image of the bomb enclosure.

A photomultiplier tube was used, in the same manner as for the nuclear burst, to detect the light from the flashlamp and generate a signal to trigger the magnetooptic shutter. A series of photographs was taken of the flashlamp for different adjustments of the photomultiplier sensitivity. The sensitivity adjustment giving the best exposure of the Sunflash was

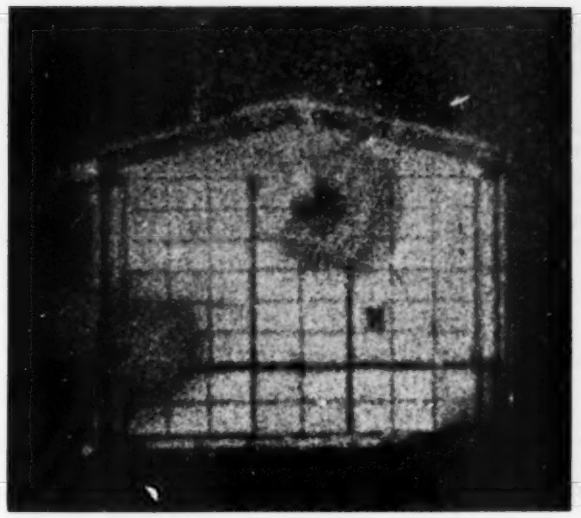

Fig. 5. Early stage of nuclear explosion in bomb enclosure showing glow of Plexiglas panes. The two darker spots represent places where radiation has come through enclosure and ionized surrounding air.

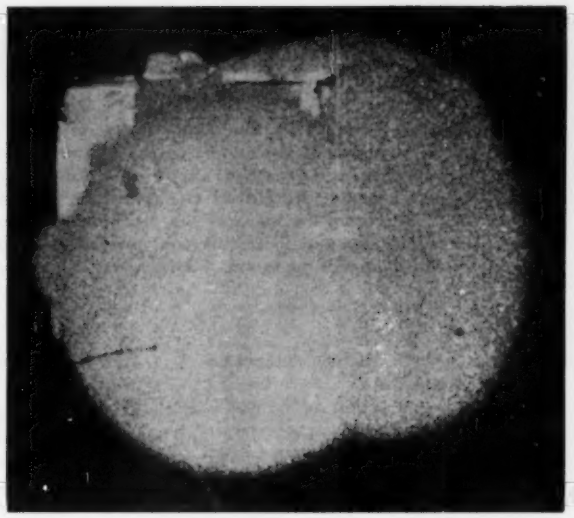

Fig. 6. State of explosion which shows glow from portion of shelter not yet engulfed by fireball as brighter than fireball itself.

taken as the standard setting for the atomic-bomb photography experiment.

Results

Figures 5 and 6 are two examples of the early stages of a nuclear explosion. In Fig. 5, the Plexiglas panes in the enclosure are glowing and prevent a view of the subject. Apparently the intense radiation has caused the Plexiglas to become a light source. In two places, however, radiation has come through the enclosure and ionized the surrounding air, causing two darker spots to appear in the picture.

In Fig. 6, the portion of the metal bomb house that has not yet been engulfed by the fireball is glowing and, in fact, is brighter than the fireball itself.

These isolated examples indicate the precision with which atomic explosions can be photographed. For a detailed analysis of the fireball growth, it is possible to operate a series of cameras set to trigger at different times or different intensities. In this way the entire growth history can be documented with accurate time definition and ultrashort exposure duration.

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Carbon-Arc Image Furnaces

By M. R. NULL
and W. W. LOZIER

Carbon-arc motion-picture projection lamps are useful in the production of extremely high flux densities of radiant energy. The application of these to carbon-arc image furnaces has been described. They are also valuable in many studies requiring high concentrations of radiant energy in any portion of the spectrum from the arc. Comparisons are made of the distribution of irradiance and illuminance across the image with three different types of optical systems. The spectral distribution of irradiance at the center of the image is also given.

A RECENT PAPER[1] by the authors described the application of carbon-arc motion-picture projection equipment in image furnaces. These are devices in which an optical system forms a small intense image of the bright carbon crater which is capable of producing very high temperatures. In particular, a double elliptical* mirror furnace was described, capable of producing temperatures in the 3500–4000 K range.

It may not generally be realized that in addition to the generation of high temperatures, this equipment is useful for producing an intense concentration of radiation in any portion of the wavelength spectrum of the carbon-arc source which extends from approximately 0.3 to 3.0 μ.

Such high-intensity beams of radiation may be useful for a wide variety of tasks. Some examples are: providing illumination of subject matter for high-speed photography; supplying illumination for schlieren optical systems, and furnishing radiation for studies requiring dispersion into a spectrum. In order to provide basic information useful for such special applications, this paper will describe the photometric and radiometric characteristics of images produced by three variations of optical systems employing elliptical mirrors commonly used with carbon-arc projection lamps.

Combinations Evaluated

The three optical systems considered in this paper are:

1. Elliptical Mirror System (enlarged image)

This system (Fig. 1) is equivalent to a conventional motion-picture projection lamp and forms an enlarged image of the source at the second focus, the position normally occupied by the motion-picture film aperture.

2. Double Elliptical Mirror System (no magnification)

As shown in Fig. 2, and as described in the previous paper,[1] this system produces a high-intensity image having essentially the same diameter as the source.

3. Elliptical Mirror System (reduced image)

This system is identical to that shown in Fig. 1, except for an interchange of the source and image positions. In this case, the elliptical mirror produces an image reduced in size compared to the source. However, as will be shown, this arrangement produces the highest image irradiance and illuminance of any of the combinations evaluated. Our attention was directed to this arrangement by some unpublished work by R. E. Harrington in our Laboratories, in 1954, which showed it capable of melting many refractory materials.

All of the data described in this paper were obtained with 11mm carbons burned in a Strong Super 135 Lamp, modified to operate at currents as high as 200 amp. Both 11mm "National" High Intensity Projector and "Ultrex" Positive Carbons were burned.†

Methods of Measurement

The methods of measurement were the same as those described earlier.[1] A water-cooled copper disk, freshly coated with magnesium oxide was placed at the image position for determination of reflected image brightness. Luminous flux incident on the image was calculated assuming perfect Lambert diffusion and 98% reflectance throughout the visible region.

The previously described calorimeter[1] was employed for measurement of total radiant flux density incident at the image plane.

The spectral energy distribution data included in this paper are taken from unpublished data obtained several years ago in our Laboratory coupled with the measurements of Table I. A quartz prism spectroradiometer was used for the measurements in the visible and ultraviolet; a rock salt prism instrument was employed for the infrared studies.

Discussion of Results

Table II lists the operational data for the carbons and the elliptical mirrors employed in the measurements. The 11mm High Intensity Carbon is the conventional "National" positive carbon, widely used for motion-picture theater projection. The "Ultrex" positive carbon burns at considerably higher current, arc power and consumption rate to produce a markedly higher crater brightness — in fact, one which exceeds 1600 c/sq mm, the apparent brightness of the sun as seen from the earth's surface.

Figures 3 and 4 show the distribution of illuminance and irradiance across the image for the three optical systems and for the two carbons evaluated. Figure 3 expresses the image illuminance data both as ft-c incident on the image and also as reflected brightness of the magnesium oxide disk placed at the image position. It should be noted that maximum illuminance at the center of the image ranges from approximately 10 million ft-c with the single mirror-enlarged image to about 260 million ft-c with the single mirror-reduced image. These values are as much as 25,000 times greater than the approximate 10,000 ft-c maximum illuminance obtained outdoors on a summer day from sunlight plus skylight.

Figure 4 shows that the central irradiance ranges from 1 w/sq mm with the enlarged images to 16.1 w/sq mm for the

Presented on April 22, 1958, at the Society's Convention in Los Angeles by M. R. Null and W. W. Lozier (who read the paper), Carbon Div., National Carbon Co., P. O. Box 6116, Cleveland 1, Ohio
(This paper was received on April 14, 1958.)

* More properly, these mirrors are ellipsoidal, but in agreement with trade custom are called elliptical throughout this paper.

† The terms "National" and "Ultrex" are registered trademarks of Union Carbide Corporation.

Fig. 1. Elliptical mirror-image furnace — enlarged image.

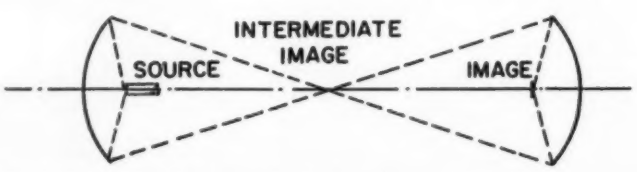


Fig. 2. Double elliptical mirror-image furnace.

Table I. Performance Data for Carbon-Arc Elliptical Mirror Image Furnaces.

Positive Carbon	11mm High Intensity, 125-amp			11mm "Ultrex," 190-amp		
Type of Furnace	Single Mirror (enlarged)	Double Mirror —	Single Mirror (reduced)	Single Mirror (enlarged)	Double Mirror —	Single Mirror (reduced)
Center of crater brightness,* c/sq mm	980	980	980	1680	1680	1680
Center of disk† brightness* c/sq mm	32.8	406	540	51.9	565	880
Brightness ratio, disk to crater	.034	.42	.55	.031	.34	.52
Max. illuminance on image, ft-c	9.7×10^6	121×10^6	161×10^6	15.4×10^6	168×10^6	262×10^6
Diam. on image for ½-peak illuminance, mm	27.7	8.0	1.7	27.2	8.5	1.8
Max. irradiance on image, w/sq mm	0.97	8.4	11.4	1.20	10.2	16.1
Diam. on image for ½-peak irradiance, mm	33.8	9.0	2.0	35.3	10.8	2.2
Blackbody temperature equivalent to max. irradiance, K	2050	3510	3750	2150	3660	4100
Luminous efficiency at center of image, lm/w	108	156	152	138	176	175

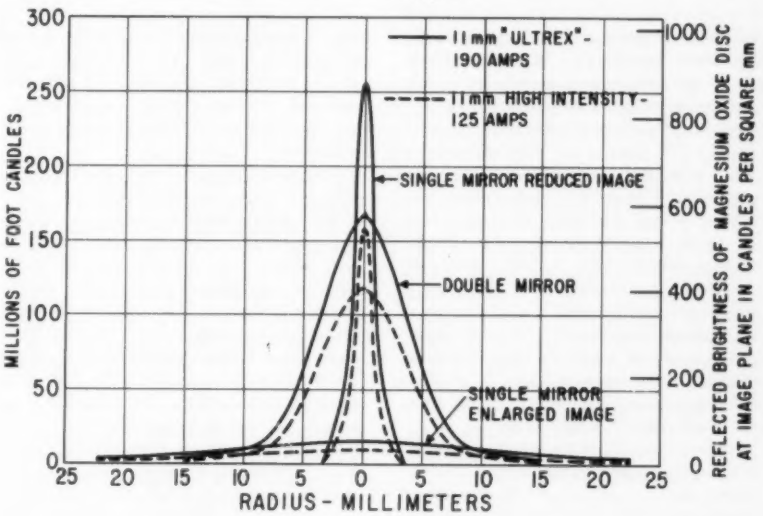
* Brightness measured along optical axis, c/sq mm.
† Brightness of a water-cooled surface of MgO at the image position.

Table II. Lamp and Carbon Operational Data.

Mirror diameter, in.	18	
Mirror to first focus, in.	6.5	
Mirror to second focus, in.	35	
Nominal mirror magnification	5.5x	
Positive carbon	11mm High Intensity	11 mm "Ultrex"
Arc current, amp.	125	190
Arc voltage, d-c v (approx.)	75	81
Arc power, kw	9.3	15.4
Positive consumption, in./hr.	25	45
Positive crater diameter, mm.	10.6	10.9
Positive crater depth, mm.	8.4	7.9
Center of crater brightness,* c/sq mm	980	1680

* Brightness measured along optical axis, c/sq mm.

Fig. 3. Distribution of illuminance across focal spot.


11mm "ULTREX"-190 AMPS
11mm HIGH INTENSITY-125 AMPS
SINGLE MIRROR REDUCED IMAGE
DOUBLE MIRROR
SINGLE MIRROR ENLARGED IMAGE
MILLIONS OF FOOT CANDLES
REFLECTED BRIGHTNESS OF MAGNESIUM OXIDE DISC AT IMAGE PLANE IN CANDLES PER SQUARE mm
RADIUS - MILLIMETERS

reduced images; these being equivalent, respectively, to the radiant emittance of a blackbody at temperatures of 2050 K and 4100 K.

Table I lists a number of values pertinent to the data of Figs. 3 and 4. These show that a magnesium oxide disk placed at the image position attains a reflected brightness of as much as 55% that of the source itself, a measure of the overall efficiency of the system in the visible region of the spectrum. The image widths at one-half of peak intensity are approximately one-fifth the source diameter for the single mirror-reduced image arrangements, are approximately equal to the source diameter for the double-mirror furnaces, and are approximately three times larger for single mirror-enlarged image combinations. Even the smallest-diameter images have been found useful in experiments on small-diameter samples where superior illuminance and irradiance were essential.

As brought out in the previous paper,[1] the flux density at the image depends upon the convergence angle at the image, on the optical system transmission and upon an integration of the source radiance or brightness (luminance) over all angles of emission intercepted by the optical system. Crater-type sources of very high brightness such as the "Ultrex" carbon show some decrease in brightness at wide angles of view from the axis. Therefore, the 40 to 60% increases in image brightness offered by the 190-amp "Ultrex" carbon compared to the 125-

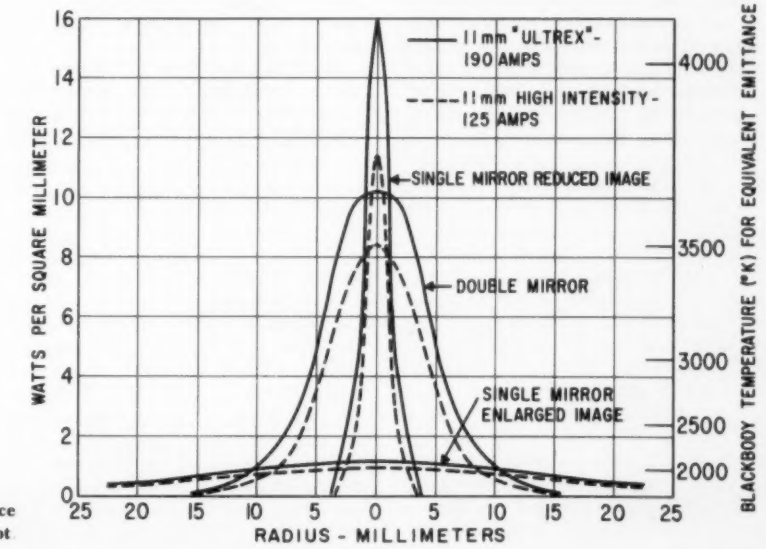


Fig. 4. Distribution of irradiance across focal spot

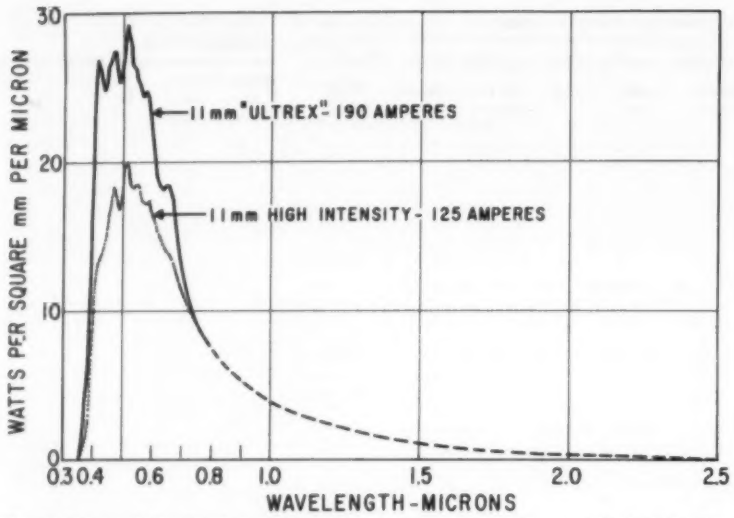


Fig 5. Spectral distribution of irradiance at center of focal spot with double elliptical mirror furnace.

amp carbon are not quite as great as the 72% increase in axial brightness. However, the single mirror-reduced image arrangement limits the mirror pickup to such small angles of collection (approximately 15° from axis) that the brightness and radiance do not decrease appreciably from the high values prevailing along the axial direction and, therefore, produces correspondingly higher image flux density than the double-mirror furnace. The increases in irradiance and brightness at the center of the image attributable to the single mirror-reduced image furnace versus the double-mirror furnace range from 30 to 35% with the 125-amp carbon to 55 to 60% with the 190-amp carbon.

Figure 5 describes the spectral distribution of irradiance at the image for the double-mirror arc image furnace. These results show that both the 125- and 190-amp carbons concentrate a major portion of their radiation in and near the visible region of the spectrum, a feature which is responsible for the well-known superior luminous efficiency of the "white flame" high-intensity carbon arc. Approximately 60 to 70% of the radiation in Fig. 5 is concentrated within the 0.4 to 0.7 μ visible range. The cutoff at 0.35 μ in the ultraviolet and near 2.5 μ in the infrared are each due to the absorption by the glass in the two second-surface reflectors.

Front-surface metal reflectors can provide increased transmission in the ultraviolet and infrared regions and extend the wavelength extremes. According to our experience, these result in some sacrifice of transmission in the visible portion of the spectrum, but not in overall image irradiance. The radiation from the "white flame" high-intensity carbon arc reaches to approximately 0.30 μ in the ultraviolet and can be extended with special corings to approximately 0.20 μ. The radiation from high-intensity carbons beyond 2 μ is roughly similar to the thermal radiation from a blackbody at approximately 3800 K. Experience has shown that no great increase can be expected in infrared emission with special corings.

Spectral distribution of irradiance data are not presented for the single-mirror image furnaces, but a study of the luminous efficiencies in Table I shows that the enlarged image arrangement of Fig. 1 provides a larger ratio of infrared and ultraviolet to visible radiation than the double-mirror data of Fig. 5, as would be expected from the elimination of one of the mirror losses. The single mirror-reduced image combination, however, produces very nearly the same division between visible and invisible radiation as does the double-mirror arrangement of Fig. 5; the improved transmission of the single mirror in the ultraviolet and infrared is approximately compensated by the higher luminous efficiency of the near-axial radiation utilized in this combination.

Each of the three optical systems has its own advantages and disadvantages which may be summarized as follows:

1. The single-mirror systems experience a single-mirror transmission loss.
2. The single mirror-enlarged image arrangement produces the largest image size and transmits the most total radiation flux to the image plane, but with relatively low flux density.
3. The single mirror-reduced image combination produces the smallest image size and the highest radiant or luminous flux density at the image.
4. The double-mirror system offers an excellent compromise between the various attributes by producing high flux density at the image, high overall transmission and the largest image size compatible with the high image flux density.

Our earlier paper showed that the air-blown carbon arc such as used in the Gretener Super Ventarc Lamp,[2] has outstanding advantages for double elliptical mirror image furnaces, particularly as regards overall power utilization efficiency, larger image in relation to source size and in adaptability to high power arcs. Such advantages are expected to carry over in large measure to the single-mirror furnaces.

References

1. M. R. Null and W. W. Lozier, "Carbon arc image furnaces," *Rev. Sci. Instr.*, 29: 163–170, Feb. 1958.
2. Edgar Gretener, "An improved carbon-arc light source for three-dimensional and wide-screen projection," *Jour. SMPTE*, 61: 516–525, Oct. 1953.

Portable Transistor Amplifier for News Recording Applications

By EDWARD M. TINK

A lightweight sound-on-film recording system has been made of a portable power supply and a miniature transistor amplifier mounted directly on the side of an Auricon 16mm camera. The power supply is housed in a standard camera gadget bag and supplies both a-c power to the camera drive motor and d-c power to the amplifier and exposure lamp. Battery replacement is kept to a minimum through the use of nickel-cadmium cells and a built-in charger.

The Auricon 16mm camera is widely used for "on-the-spot" news coverage. The Cine-Voice, the smallest camera in the Auricon line, has a film capacity of 100 ft ($2\frac{3}{4}$ min), and is often used as a news camera. The Cine-Voice is housed in a portable case having a total weight of 45 lb or in 2 smaller cases with a total weight of 60 lb. Although the vacuum tube amplifier is portable, by virtue of its self-contained battery power supply, the camera itself requires a source of 115-v, 60-c power to operate its drive motor. Thus, the camera system cannot be operated at a location remote from 115-v power lines unless an additional portable 115-v a-c power pack is available.

The Engineering Department at WLAC-TV (Channel 5, Nashville, Tenn.) planned a much smaller and more desirable system by substituting a miniature transistor amplifier, mounted directly on the camera, for the vacuum tube amplifier. In order to make the system completely portable, it was decided to provide a portable 115-v a-c power pack. The Dormitzer Model DY-1012 portable a-c power pack was selected.* This unit employs two 6-v Dyna Seal nickel-cadmium cells, connected in series, driving a vibrator and transformer which supplies a 115-v, 60-c ouput and was designed particularly for use with the Auricon Camera. The nickel-cadmium cells in this supply have an extremely long life and are maintained at the proper voltage by a built-in, battery-charging circuit. Since this unit does contain a rather stable 12-v d-c source, it was reasoned that it could be used to supply collector voltage to the transistor amplifier and current to the sound exposure lamp in the camera, and thus eliminate all additional batteries. Having decided upon a basic system, the next step was the design of the transistor amplifier.

As a starting point, specifications were obtained from Berndt-Bach, Inc., manufacturers of the camera, for an amplifier to drive the variable-area galvanometer in the Cine-Voice Camera. This galvanometer has an impedance of 10 ohms at 400 c and is designed to be driven from a 50-ohm source with a 40-ohm series isolating resistor. One-hundred per cent modulation is represented by an output of 1.6 v rms (52 mw) across the 50-ohm output. The equalization needed for speech recording requires a frequency response of −12 to −14 db at 100 c, +3 db at 3000 c, and 0 db at 5000 c.

As is normally the case, the design of the output stages of the amplifier presented the greatest challenge. Since low distortion was one of the primary goals, it was decided that the output circuit should be "Class A Push-Pull." Due to its greater power sensitivity, the common emitter configuration was used. A thorough search of the available miniature transistor output transformers indicated that there were practically none which were designed to work into a 50-ohm load. The vast majority are made to match loudspeakers, having a secondary impedance of 4, 8 or 16 ohms. Several unsuccessful attempts to use transformers at impedances other than that for which they were intended, convinced us that this was not a practical approach. It was also observed that all of the transformers tested for use in this circuit had relatively low efficiencies. The highest measured efficiency was 50% and the lowest was 15%!

For the reasons stated above, it was decided that a better solution to the problem of obtaining the proper output transformer was to have one designed for this particular application; consequently, the Transformer Design Section of the Electronics Division of Aladdin Industries, Nashville, Tenn., was presented with the problem. A ferrite core transformer was designed which proved to be satisfactory and had a measured efficiency of more than 70%. The design of this transformer was somewhat simplified by the fact that the low-frequency requirements of the amplifier were not too severe. One of the greatest objections to the use of the ferrite core is that it saturates quite easily, and therefore the effective d-c current through the primary winding must be kept very low. It was at first thought that the requirement of a very low value of d-c unbalance in primary current would require the use of matched output transistors. This, however, did not turn out to be a problem, since all of the output transistors which were used at various times (2N43's, 2N44's, and 2N118A's) were matched within less than 1 ma.

Considerable attention was given to the collector dissipation rating of the output transistors before the General Electric Type 2N43 transistor was chosen. Due to the low collector-to-emitter voltage available (approximately 10 v) it was necessary to operate the collectors near their maximum dissipation rating in order to obtain the required output power with low distortion. The allowable transistor power dissipation is dependent upon the maximum ambient temperature which will be encountered, and is given by the expression

$$P = \frac{85°C - TA}{K}$$

where TA = maximum ambient temperature, and K = thermal resistance in deg C/mw.

It was felt that the amplifier might be expected to operate in ambient temperatures as high as 110 F (43C). Since the thermal resistance for the 2N43 is 0.2C/mw (with a heat sink whose minimum area is 0.95 sq in.), the dissipation must be limited to 210 mw per transistor. This limits the collector current to a maximum of 21 ma with a collector-to-emitter voltage of 10 v. Several different types of heat sinks were contemplated, but the final model consisted of a 1-in. sleeve made of copper tubing. It is very important that good thermal contact be maintained between the transistor body and the heat sink, and for this reason it is advisable to remove the paint from the transistor body. One further word of caution: the G.E. transistors have the base connected electrically to the case, and it is therefore necessary to isolate the heat sinks from ground.

Although a theoretical maximum efficiency of 50% is possible in a class A output stage, the output power is quite often limited to a value which results in a lower efficiency. This is due to clipping in the collector circuit which results when low values of collector-to-emitter voltages are used. With a d-c collector-to-emitter voltage of 10 v, the maximum peak-to-peak excursion of voltage across the transformer is slightly less than 40 v. With a turns ratio of approximately 5.5 to 1,

Presented on October 22, 1958, at the Society's Convention at Detroit by Edward M. Tink, WLAC-TV, Inc., 159 Fourth Ave. No., Nashville, Tenn.
(This paper was received on September 22, 1958.)

* Made by Dormitzer Electric & Mfg. Co., 5 Hadley St., Cambridge 40, Mass.

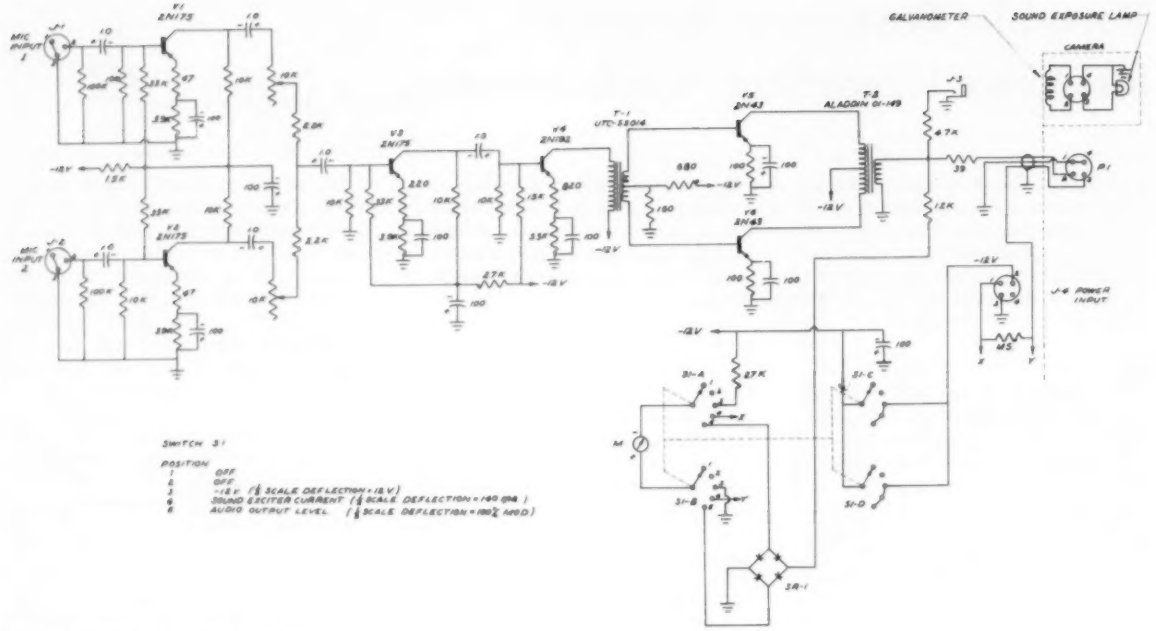


Fig. 1. Schematic of transistor amplifier.

the maximum voltage across the 50-ohm secondary will be approximately 7 v peak-to-peak. Thus, the maximum power output before clipping occurs will be in the vicinity of 125 mw. The power output could be greatly increased by using a slightly larger value of collector voltage, but this would require an additional battery with a resulting increase in size and weight of the power pack. Figure 1 shows that the emitter circuits of V5 and V6 contain 100-ohm resistors to ground. These resistors are inserted in series with the emitter-to-base junction to help prevent thermal runaway. In addition, base voltage stabilization is obtained by the low-impedance network consisting of R28 and R29. The effectiveness of these two stabilizing networks is well demonstrated by the fact that the stability factor for these stages as determined by the relationship:

$$S = \frac{dIc}{dIco} = 1 + \frac{(R29)(R28)/R29 + R28}{R30}$$

is 2.2†

It was felt that this degree of stabilization was quite adequate and therefore no nonlinear stabilizing units were employed. It should be pointed out, however, that this degree of stabilization was obtained at the price of lower output power. This is true because the allowable collector-to-emitter voltage swing is reduced by approximately twice the value of the d-c drop across the emitter circuit. In this case, the emitter current is 20 ma so the d-c voltage drop in the emitter circuit is 2.0 v and the available collector-to-emitter voltage swing is reduced by 4 v.

The driver stage employs a G.E. 2N192 transistor coupled to the output circuit by means of a United Transformer Co. SSO-14 transformer. The relatively large value of R27 in the emitter circuit, and the base voltage stabilization, again contribute to excellent temperature stability (S = 2.5). In addition to R27, a smaller un-by-passed resistor (R26) is also placed in series with the emitter. This provides approximately 16 db of gain reduction and results in excellent overload characteristics and uniform gain and frequency response with variations in transistor parameters.

The two input stages (V1 and V2) and the following stage (V3) all employ the RCA 2N175 low-noise transistor, and it will be noted that these three stages are almost identical so far as their common components are concerned. Again, good temperature stability is obtained by the methods used in the driver stage and in addition d-c collector-to-base feedback is employed ($S = 3$ for V1 and V2; and $S = 2.3$ for V3). The un-by-passed emitter resistors result in a gain reduction of 12 db in V3 and 5 db in V1 and V2. It will be noted that the two microphone inputs do not employ transformers but rather are resistance-coupled to V1 and V2. Although some additional gain would result with input transformers, their use was not considered necessary. The output level of V1 and V2 is regulated by the two gain controls R12 and R15, and when two microphones are used, the signals are mixed in the combining network consisting of R15, R16, and R18. There is a maximum interaction of 5 db between the two gain controls under the worst possible condition; i.e. feeding a signal in on channel 1 and changing gain control 2 from minimum to maximum. Measurements indicated that no frequency discrimination occurred at any combination of settings of the gain controls.

A miniature switchable meter (0–1 ma) was included in the circuit to be used to measure the following: (1) 12-v d-c from the batteries, (2) sound exposure lamp current and (3) audio output level. The shunts and multipliers were so calculated that the proper values of voltage and current, in all three meter positions, resulted in exactly half-scale deflection. Thus, it was unnecessary to calibrate the meter face.

As was mentioned previously, the basic power supply for amplifier and camera was Dormitzer Model DY-1012 Portable Power Pack. The circuit for this unit is shown in Fig. 2. It was necessary to make some wiring changes in the original unit in order to obtain the proper polarity for the 12-v d-c output. Since the original rectifier in the battery-charging circuit was of such physical construction as to ground its plate through its mounting hardware, it was also necessary to replace this element. The only other changes in this unit were the elimination of one of the parallel pilot lamps in the battery-charging circuit (to bring the charging current down to 450 ma, which is within the rating of the new rectifier), and the insertion of a potentiometer to control the sound exposure lamp current. A small additional case was fastened to the side of the power pack to house a one-hour timer, for the purpose of preventing

† Paul Penfield, Jr., "Transistor bias stabilization," Pt. I, *Audio, 40:* 34; Pt. II, *ibid.*, 20, July 1956.

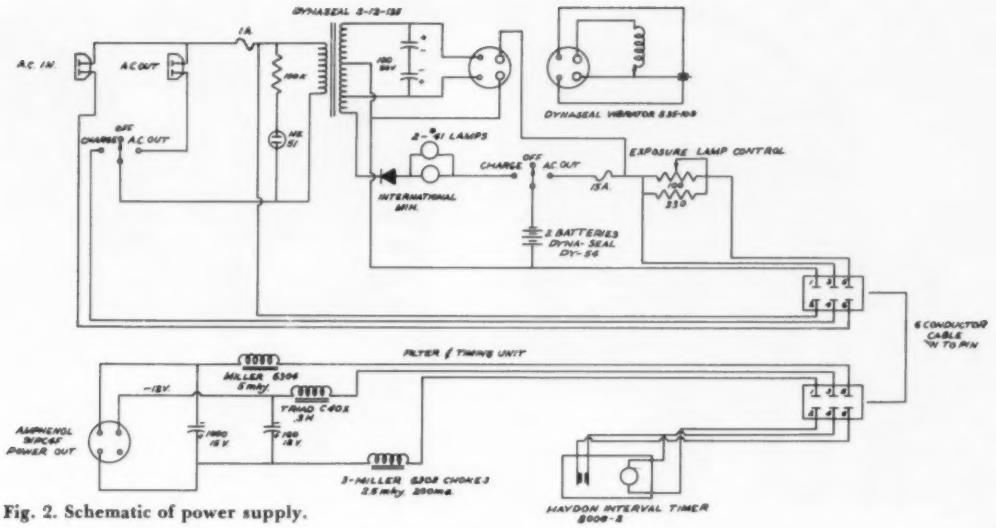


Fig. 2. Schematic of power supply.

battery overcharge, and filter components for the 12-v d-c used to supply the amplifier and sound exposure lamp. A large amount of filtering was required to remove the vibrator hash from the battery leads. This filtering problem was further complicated by the fact that only a very small d-c voltage drop could be tolerated across the series filter elements, since this drop reduced the available collector voltage in the amplifier.

The performance characteristics of the amplifier were very good. A signal-to-noise ratio of 56 db was measured in both channels. Since each channel has a gain of approximately 80 db, this results in an equivalent noise input of −136 db! The harmonic distortion, measured at 1000 c across the 50-ohm secondary winding, was 1.9% with an output level of 1.6 v rms (100% modulation). As previously mentioned, the manufacturer recommended that for speech recording the amplifier low-frequency response be −12 to −14 db at 100 c. The measured response was down 14 db at 250 c, but listening tests indicated that this slight deficiency in low-frequency response was not at all objectionable. The distortion increased to a value of 3.2% at 250 c. As the frequency increased beyond 1000 c, the distortion remained equal to or less than 1.9%. Using 1000 c as a reference, the high-frequency response was flat within ±1 db to 9000 c, which is beyond the upper limit of 16mm sound-on-film recording capability. All of the above measurements were made with a 10-ohm resistor substituted for the camera galvanometer.

The general details of the mechanical construction of the amplifier can be observed by referring to Fig. 3. It will be noted that the majority of the components were mounted on a perforated phenolic board using plug-in terminals as tie points. All of the transistors, with the exception of the two in the output stage, were mounted to the board by means of clips, and electrical connections were made by soldering the transistor leads directly to near-by terminals. The two output transistors were pressed into short pieces of copper tubing which were in turn fastened to the board and served the dual function of heat sinks and mounting clips. Particular care was taken while making these soldered connections, since it is possible to damage the transistors permanently if they become overheated. This problem is particularly aggravated in the case of the 2N175 transistors, since they are supplied by the manufacturer with leads approximately $\frac{1}{4}$ in. in length. Figure 4 shows the opposite side of the amplifier. All of the capacitors are of the miniature electrolytic type manufactured particularly for transistor use.‡ The two gain controls and the meter switch are a miniature type.§ The two microphone jacks, and the power input jack are standard Amphenol connectors. Several minia-

‡ Made by International Electronics, Inc., Fessey Park Rd., Nashville, Tenn.

§ Made by Centralab, 900 East Keefe Ave., Milwaukee 1, Wis.

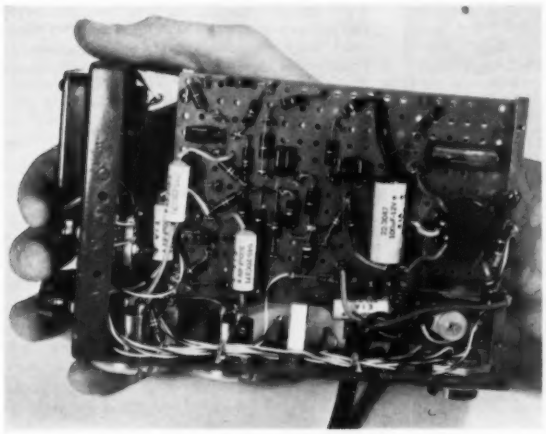


Fig. 3. Right side of amplifier chassis.

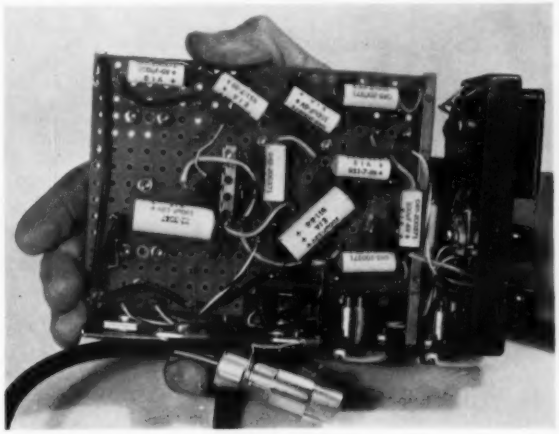


Fig. 4. Left side of amplifier chassis.

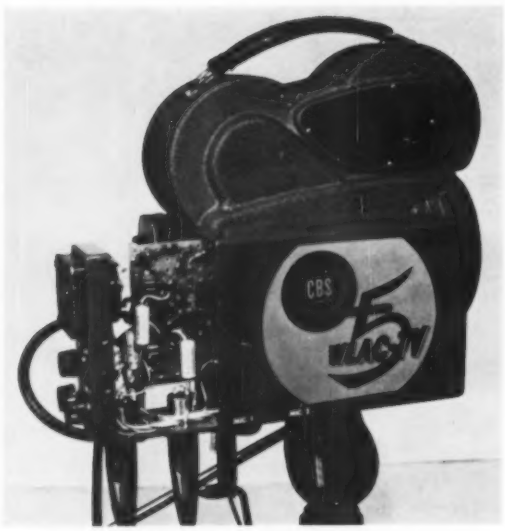


Fig. 5. Amplifier chassis partially removed from housing.

Fig. 6. Components of system: camera, amplifier, power supply, microphone and ear phone.

ture microphone connectors were considered but it was decided that they were not sufficiently rugged for this application.

Figure 5 shows that the L-shaped chassis containing all of the electrical components slips into a small metal housing which is in turn bolted directly to the side of the camera. For access to the amplifier, it is merely necessary to remove a few mounting screws and slide the amplifier out of the housing. To secure the housing to the side of the camera, it was necessary to completely disassemble the camera. Fortunately, this did not turn out to be too difficult an operation for a qualified camera repairman.

The portable power supply is mounted in a commercial camera gadget bag. This bag is carried by means of a shoulder strap and contains sufficient storage space for the microphone and power cables, as well as spare film. Figure 6 shows all of the components of the completed camera system.

The camera (with amplifier) weighs 16 lb and the power supply accounts for an additional 20 lb, making the complete system (less tripod) weigh 36 lb.

This camera has been in use for a period of nine months by the news department at WLAC-TV, and results indicate that its operation is quite reliable and that good-quality sound-on-film recordings are readily obtained by personnel not particularly accustomed to operating electronic equipment.

The author would like to take this opportunity to express his appreciation to Ralph L. Hucaby, Chief Engineer, WLAC-TV, for his assistance in this project and to the station engineering personnel who so skillfully constructed the final model.

Discussion

Charles F. Quentin (KRNT, Des Moines). How did you provide equalization in the amplifier to take care of high-frequency losses in the film processing?

Mr. Tink: The manufacturer recommended that the response of the amplifier be modified so that it would be down 14 db at 100 cycles and relatively flat from 1000 to 5000 with a sharp roll-off past this point. This response would insure the proper equalization for good speech reproduction. In this particular amplifier, we were down more than 14 db at 100 c due to the fall-off in low-frequency response of the output transformer. Thus the frequency-response characteristics of this transformer actually took care of all the low-frequency equalization. We did not attenuate the response of the amplifier past 5000 c since the signal-to-noise ratio was good enough to make it unnecessary.

Mr. Quentin: I was very much interested in the power supply — about how many minutes can you record or, should I say, what is the hour capacity of the power supply?

Mr. Tink: I can't give you an exact figure, but I know that in experimenting with the unit I've used it as long as a half-hour at a time with only a small fall-off in voltage. That's due, of course, to the nickel cadmium cells keeping their charge.

Jack D. Sellers (Michigan Bell Telephone Co.): Had you thought of using the new transistor-type power supply in order to eliminate the hash filter?

Mr. Tink: We did not give it much consideration.

Mr. Sellers: I understand they are much more efficient than the vibrator types.

Mr. Tink: I believe they are, but it happened that we already had in our possession a battery pack made from the same type of battery which we used to supply a portable floodlight. We were pleased with this particular nickel cadmium battery and wanted to use it again. In looking through the literature, we came across this power supply designed particularly for the Auricon. That was our main reason for using this technique. Possibly we should have investigated further the possibility of a transistor converter. Even if a transistor converter had been used, however, the batteries could not have been reduced very much since the sound exciter lamp requires a considerable amount of power. If a synchronous motor were used in the camera, it would also be necessary to control closely the frequency of the output of the transistor converter.

The Marconi 16mm Fast Pulldown Television Recorder

By M. E. PEMBERTON

A recording monitor which produces a high-quality TV picture, and a new 16mm fast pulldown camera which is used to record the picture are described, and performance data are presented.

THE OBJECT of the Marconi 16mm fast pulldown television recorder is to produce a 16mm film with the recorded television picture taking the place of the normal photographic image. The making of a standard film has many advantages such as ease of viewing and editing, interchangeability and the making of copies.

The complete channel consists of the following:

1. Recording monitor
2. 16mm fast pulldown camera
3. Camera drive chassis
4. Regulated power supply
5. Auxiliary power supply
6. Control desk with a 5-in. waveform monitor and a switching unit.

No sound equipment is shown because this is usually magnetic and therefore can be treated separately. We have, however, fitted to the fast pulldown camera, operating on an equipment supplied to the B.B.C., a standard 16mm G.B-Kalee photographic sound recording head. On this equipment married negatives or positives can be produced straight away, and the quality of the sound is very good.

The channel is shown in Fig. 1, demonstrating the accessibility of the various parts of the channel. This is an important feature if a fault is to be rectified as quickly as possible.

The recording monitor contains all the circuits for forming a high-class TV picture which is then recorded by the 16mm fast pulldown camera. The recorder is controlled from the desk by an operator who, when seated, can see the picture which is being recorded.

A probe amplifier fitted to the back of the recording monitor enables any high- or low-impedance point to be monitored at 75 ohms by the operator on the 5-in waveform monitor fitted above the desk. Underneath the 5-in. waveform monitor is a switching unit, together with the picture and sound-level controls seen on the right. The switching unit enables various picture and sound inputs, either program or test, to be selected.

Presented on October 23, 1958, at the Society's Convention at Detroit by D. S. Wigglesworth for the author, M. E. Pemberton, Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, England.
(This paper was received on November 3, 1958.)

The camera drive chassis synchronizes the speed of the camera with the TV picture repetition rate. It generates from the TV field pulses, using thyratrons in a standard inverter circuit, the total power for the camera motor. The camera motor is a $\frac{1}{16}$-hp synchronous motor polarized with magnets. The polarization is necessary to stop the motor from locking-in wrongly phased.

The power supplies for the channel are obtained from the auxiliary power supply and the regulated power supply. A regulated voltage of 250 v, 1.5 amps, can be obtained from the regulated power supply which has a metal rectifier.

Recording Monitor

A close-up of the recording monitor with its side covers off and the field-scan chassis folded out for servicing, is shown in Fig. 2.

The recording monitor contains the following:

1. Field scan generator
2. Line scan generator
3. Blanking chassis
4. Amplifier chassis
5. The deflector and focus coil assembly (includes spot-wobble and focus-modulation coils)
6. EHT (high-voltage) unit
7. Probe amplifier—which is on the back and is not shown.

The first four chassis are of similar construction and they can be folded out for servicing as shown in Fig. 2. The blanking chassis can be seen in Fig. 2 above the

Fig. 1. The recording channel showing the accessibility of various units.

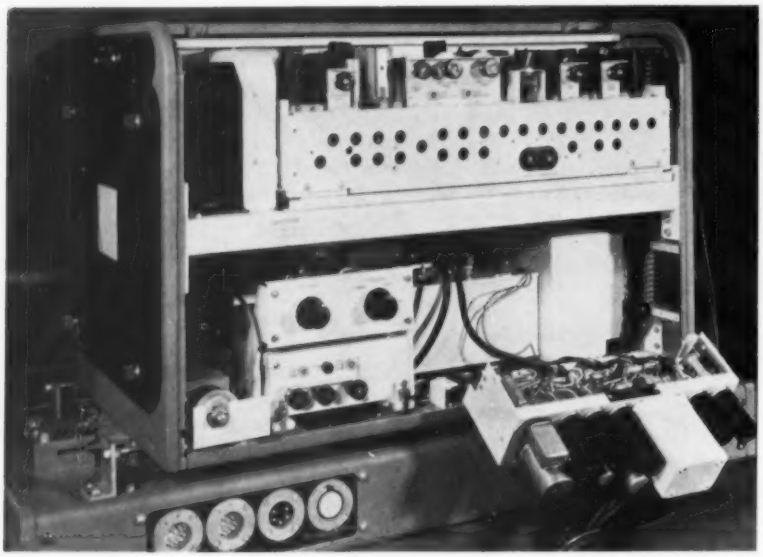


Fig. 2. The recording monitor with side covers off and the field-scan chassis folded out for servicing.

field-scan chassis. The amplifier and line-scan chassis are on the other side of the case. The case was designed to take from 5-in. to 10½-in. diameter cathode-ray tubes.

Since the deflector and focusing system can have such an effect on the overall focus on the recording cathode-ray tube, considerable effort went into the design of this sytem. The focus coil is unshielded and the scanning coils are toroidally wound. All magnetic material has been avoided in the construction of the recording monitor case, and controls are provided for aligning the focus accurately around the electron beam of the cathode-ray tube. The focus coil can be switched to an a-c supply to help in this alignment.

The field and line-scan generators are of conventional design. The power required is not high. It is of the same order as the power required to drive an ordinary television receiver with a 90° angle cathode-ray tube.

The EHT (high-voltage) unit was designed to give the highest voltage and still be of reasonable enough size to fit into the recording monitor case. This was done by using a ringing choke to feed six rectifiers connected so as to multiply the voltage six times (Cockroft-Walton circuit). The components operating at high voltages are immersed in oil. In Fig. 2, the high voltage can which is 8 in. by 5 in. by 4 in. can be seen behind the field-scan generator, with the low-voltage chassis in front followed by two high-voltage smoothing condensers. The complete unit gives a stabilized output of 25 kv ± 0.5% up to a current of 400 μa.

The picture circuits are spread over the blanking and amplifier chassis. It was decided to fit into the video chain transfer characteristic and high-frequency correction circuits, normally built into separate units. This results in quite an appreciable reduction in the number of valves (tubes), and it was considered worth while even if it meant a restriction in the range of these corrections. The corrections, however, that we found possible to provide have proved in practice quite adequate. It has been found possible to cover even the rather large corrections necessary for direct positive recordings.

The maximum high-frequency correction available is: +6 db at 3 mc; +10 db at 5 mc; and +12 db at 7 mc.

This correction is not phaseless. The slight overshoots introduced, which are not visible on the final recording, we think improve the result.

The transfer characteristic correction or black and white stretch available is shown in Fig. 3. The "onset" is the level at which the black or white stretch starts to operate.

The output of the video chain can be 90 v with the following frequency response: ±0.2 db to 7 mc; −1 db at 8 mc; −4 db at 9 mc; −10 db at 10 mc.

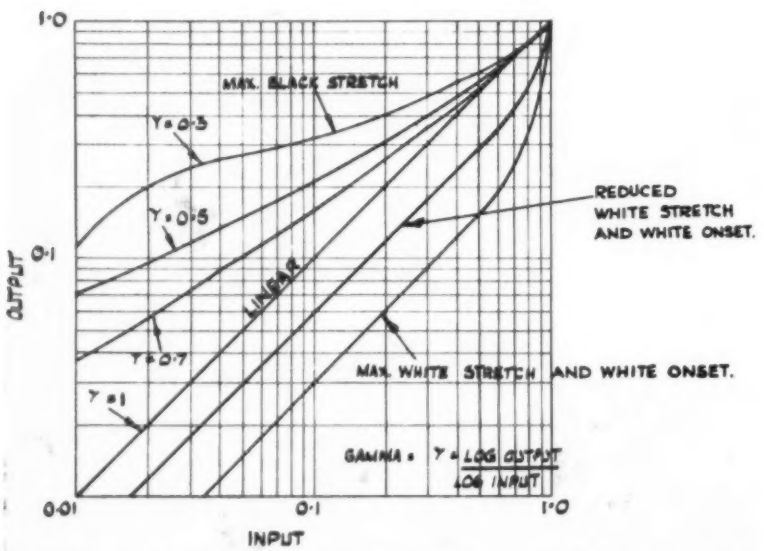


Fig. 3. Curves of the transfer-characteristic correction or black and white stretch available from the video chain.

16mm Fast Pulldown Camera

The 16mm fast pulldown camera is shown in Fig. 4. The fast pulldown mechanism is totally enclosed in an oil bath and was designed to be quickly removable from the camera.

Many previous attempts had been made, with little success, to build a fast pulldown mechanism suitable for television. It was, however, the work of Isom, who designed a projector for RCA[1] using the principle of acceleration in stages, which encouraged us to proceed with the development of a fast pulldown mechanism.

The fast pulldown mechanism which finally proved successful was one based on an idea by A. Kingston,[2] shown diagrammatically in Fig. 5.

The fast pulldown is obtained in a three-stage accelerator. The sapphire-tipped claw G is mounted onto a shuttle F which is driven by a 96° cam E. This cam is driven via the two links D and C by the polarized synchronous motor A at a speed of 50 rps in the 50-c model. Cam E rotates at twice the film speed of 25 frames/sec, and the claw G does one stroke without moving the film. The claw is moved into the film perforation by the

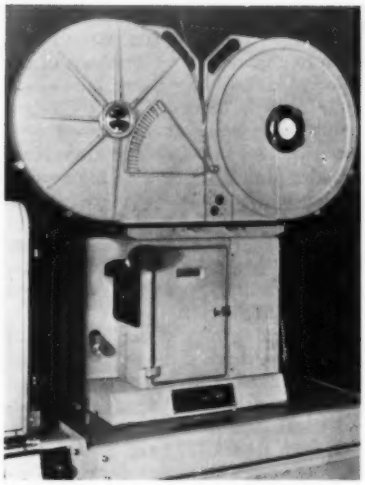


Fig. 4. The 16mm fast pulldown camera as manufactured by Rank Precision Industries (B.A.F.) Ltd.

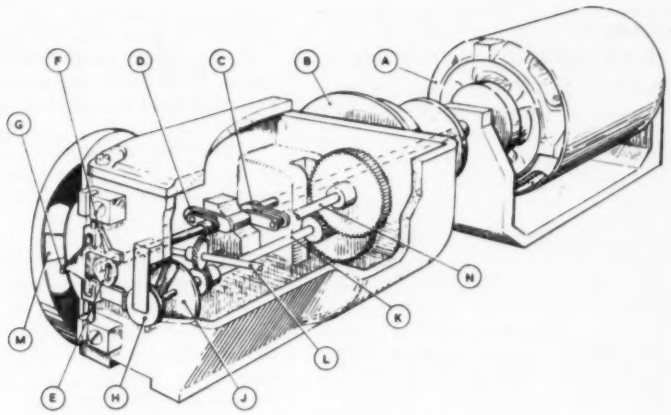


Fig. 5. A diagrammatic sketch of the fast pulldown mechanism.

cam wheel H which is moved by the cam J once per film frame. Since the cam E is rotating at twice the film speed, its effective pulldown angle is reduced 2:1 to 48°. The links D and C reduce this angle further. Each link consists of a pin which slides in a slot. These pins are fitted to a common shaft so as to counterbalance each other. The acceleration introduced by each link depends on how far this shaft is offset. This shaft can be easily adjusted to alter the pulldown time of the camera, an important feature of the mechanism. If the acceleration introduced by each link is 2:1, then the pulldown angle will be 48/4 = 12° or 1.33 msec.

Due to the persistence of some cathode-ray-tube phosphors, the film may be exposed during the pulldown and blurred, unless a shutter is provided. A two-bladed shutter M driven from shaft L at 25 rps is therefore fitted. Shaft N runs at constant speed and drives the camera sprockets.

In the case of the 60-c model, the motor runs at a speed of 60 rps and the standard film speed of 24 frames/sec is obtained by using a 2,3 sequence. The TV field rate is 60/sec and the film is pulled down after two TV fields and then after three TV fields. The shutter M not only has to cover the pulldown, but it has to equalize the exposures per pulldown, by covering up one of the TV fields. It is fitted with four blades which rotate at 12 rps; three of these blades are narrow, sufficient only to cover the pulldown, while the fourth is wide enough to blank out the appropriate field. This pulldown cycle does not, of course, involve any picture splice which is necessary in conventional 60-field recording systems.

The estimated load of the film was only 10% of the total load on the mechanism. In view of this, to speed up the life tests it was considered unnecessary to run film all the time. The first model of the fast pulldown mechanism was run for 3000 hr including 450 hr with film at a pulldown time of 2.1 msec. No change in this pulldown time was detected. The tests were abandoned because it was obvious the mechanism would run for many more thousand hours.

The life of the film was quite amazing. Loops of approximately 7 ft with one splice were run through continuously until they broke at the splice or at a perforation. With this length of film, each part of the loop was pulled through the gate five times a minute, or 300 times an hour. One of these loops ran for 10 hr, or 3000 times through the gate.

Apart from the fast pulldown unit, the design of the camera is along conventional lines. It is built to professional standards with loss of loop, loss of take-up and film-break cutouts.

Control of the Channel

To obtain consistent results, the complete recording process must be tightly controlled. A television recorder has the advantage over normal photography in that the exposure can be made constant and no printer light variations should be necessary.

The individual gamma or transfer characteristics, γ, of the recording process

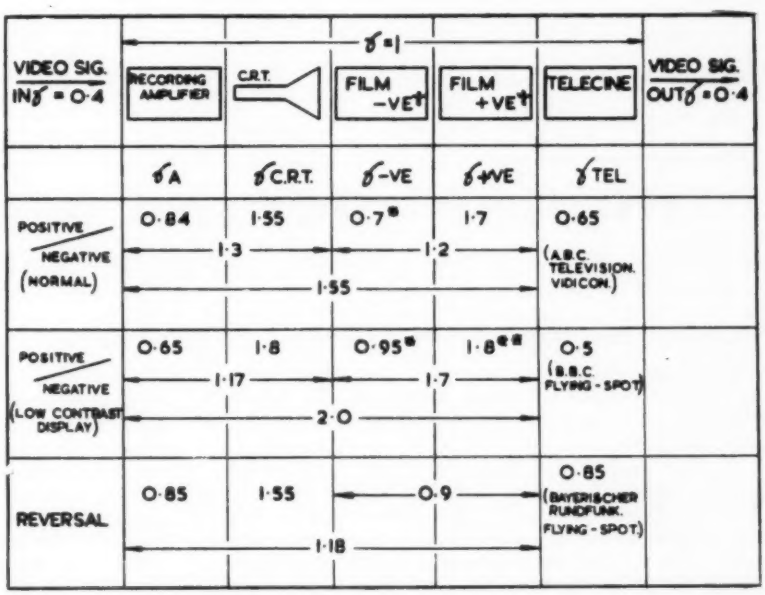


Fig. 6. The individual transfer characteristics, γ, of the recording chain with typical examples of the transfer characteristics adopted operationally by three different users of the recording equipment. γ = log out/log in.

* This value is the "Gamma Bar" which is the mean slope of the negative characteristic. It is not the slope of the straight-line portion, which is used in the control of the negative processing.

** This is normal positive processing. It is the gamma obtained by varying the intensity rather than time, as is usual in the standard Eastman Kodak 11B system. The equivalent 11B gamma is 2.5.

† −ve, gamma negative; +ve, gamma positive.

are shown in Fig. 6 with a few typical examples.

For no distortion in the recording

$$\gamma\text{Amplifier} \times \gamma\text{CRT} \times \gamma \text{ negative} \times \gamma \text{ positive} \times \gamma\text{Telecine} = 1$$

where

$$\gamma = \frac{\text{Log output}}{\text{Log input}}$$

The transfer characteristic of an average TV receiver is approximately 2.5; so, to match this, the TV camera should have a transfer characteristic of 0.4. The outgoing signal from the telecine when playing back a recording should, therefore, also have a transfer characteristic of 0.4.

The control of the recorder is divided into four stages:

(1) the setting up of γAmplifier by using a ten-step staircase waveform;

(2) the setting up of the correct black-and-white levels on the recording cathode-ray tube and, hence, indirectly setting γCRT;

(3) the control of the film processing both γ negative and γ positive by exposing a seven-step wedge placed in the front of the cathode-ray tube which has been set to peak white brightness; and

(4) the setting up of the telecine γTelecine to give a linear output from the ten-step staircase used in the setting of γAmplifier.

In addition, a resolution pattern should be introduced so that a check can be made on the overall resolution.

Performance

The recorder is in use in Germany, Australia, Czechoslovakia and England, and its reliability has been well proven. There is no doubt that the type of accelerators used in the camera is working well within its limits, and that a reduction of the pulldown time is possible. Whether in practice this is worth while seems very doubtful, because at the present pulldown time the loss of information in any of the 405-line or 625-line installations is negligible.

The camera pulldown time is normally set to 1.9 msec and the shutter which produces a fade increases this time to an estimated 2 msec. The decay time of the recording cathode-ray-tube phosphor, however, helps to fill in some of the lost information.

We claim a pulldown time of 2 msec; whether we could, in fact, claim less is open to argument. The steadiness of the camera is difficult to measure, but we estimate it is of the order of 1 in 600. The best results have been obtained using low-speed 12/10–15/10 DIN fine-grain blue-sensitive film. The following films are at present in use in the equipment: Perutz U15 Reversal; West and East German Agfa Isopan F Reversal: East German Isopan FF negative; and Eastman Telerecording Film, Type 7374, and Type 8374 (gray base).

The making of a direct positive has proved to be the most economical method of recording. The film processing is even less than that required to make a standard release positive from a normal negative. Both Kodak 7374 and 8374 are being used successfully to do this type of recording. The direct positive has the advantage over the rescanning of a negative in that any dust on the film comes out black in the final picture.

References

1. Warren R. Isom, "Fast-cycling intermittent for 16mm film," *Jour. SMPTE, 62:* 55–63, Jan. 1954.
2. British Pat. Applic. 30543/54.

motion-picture standards

Proposed Revision of American Standard, PH22.76–1951

A proposed revision of American Standard Threaded Lens Mounts for 16mm and 8mm Motion-Picture Cameras, PH22.76-1951, is published here for a three-month period of trial and criticism.

The 16 & 8mm SMPTE Engineering Committee began their study of the subject standard in 1956 in accordance with the Ameriean Standards Association requirement that all standards be reviewed every five years. The first draft of the proposed revision was opposed because the mount designations, formerly No. 1 and No. 2, did not conform to current industry practice. The second draft, redesignating the mounts as "D" and "C," respectively, was accepted by the Committee. This standard differs from the present 1951 standard in that the reference to the A, B, C, and D dimensions have been changed to W, X, Y, and Z in order to avoid confusion with the mount designations. Several changes have also been made in the title, notes, and appendices in order to clarify the standard.

This draft was approved by the Standards Committee in January 1959 and is the one published here for comment. All comments should be sent to the Staff Engineer prior to May 15, 1959. If no objections are received, the proposal will then be submitted to ASA Sectional Committee PH22 for further processing as an American Standard.—*J. Howard Schumacher*, Staff Engineer.

Proposed American Standard

Threaded Lens Mounts for 16mm and 8mm Motion-Picture Cameras

PH22.76

Revision of PH22.76-1951

1. Scope

1.1 This standard specifies the dimensions required for mechanical and optical interchangeability of lenses for 16mm and 8mm motion-picture cameras. For 16mm cameras with threaded lens mounts, threads having a nominal major diameter of 1 in. are often specified. Similarly, for 8mm motion-picture cameras, threads having a nominal major diameter of ⅝ in. are in common use.

1.2 This standard does not apply to continuous-type motion-picture cameras because of the type of optical systems employed in these cameras.

1.3 The notes are a part of this standard.

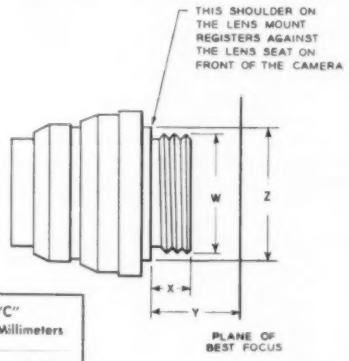
2. Dimensions

2.1 The dimensions shall be as specified in the diagram and table.

2.2 The lens mounts shall have 32 threads per inch.

2.3 The form of the thread shall be in accordance with American Standard Unified and American Screw Threads for Screws, Bolts, Nuts, and Other Threaded Parts, B1.1-1949, or the latest revision thereof approved by the American Standards Association, Incorporated.

2.4 Limiting dimensions and tolerances of the threads shall be class NS-2A for the external threads on the lens. These dimensions shall include plating or any other finish.



Dimension	Mount "D" Inches	Mount "D" Millimeters	Mount "C" Inches	Mount "C" Millimeters
W	0.625	15.88	1.000	25.40
X	0.115	2.92	0.160	4.06
Y	0.484	12.29	0.690	17.53
Z	1.000	25.40	1.187	30.15

NOTES

1. The values specified for dimension X are the maximums for the lenses; additional length for clearance should be provided in the camera. With some lenses the section of the mount, smaller in diameter than the root of the thread, extends beyond the limit of dimension X towards the plane of best focus. For such lenses, clearance must be established individually.
2. For the lens, dimension Y is the distance from the registering shoulder to the plane of the best overall image. For the camera, dimension Y is the distance from the registering shoulder to the plane that best represents the location of the emulsion on the film in a camera operating normally. The allowable tolerance for dimension Y depends upon the f/value of the lens and other variables, and so is not suitable for definite standardization. A tolerance of ± 0.001 in., applied independently to the lens and camera, is suggested as a generally accepted practice.
3. The values given for dimension Z are maximum diameters for the seat on the lenses; the seat on the camera shall provide clearance for these diameters.

NOT APPROVED

APPENDICES

(These Appendices are not a part of Proposed American Standard Threaded Lens Mounts for 16mm and 8mm Motion Picture Cameras, PH22.76, but are included to facilitate its use.)

APPENDIX 1

Past practice has not been entirely consistent so far as dimension X of the "D" mount is concerned. Some existing cameras will not accept a thread longer than 0.115 in.; some lenses have been made with a length of 0.120 or 0.125 in.

APPENDIX 2

If any part of the lens mount has a larger diameter than dimension Z, it should be checked for mechanical interference with the camera on which it is to be used.

NOT APPROVED

Film Brittleness Standard

An American Standard Method for Determining the Brittleness of Photographic Film, PH1.31-1958, has been approved by the American Standards Association.

The standard gives three test methods for obtaining a quantitative measure of the brittleness of photographic film: Folding Endurance Test, Wedge Brittleness Test and Vise Brittleness Test. The tests can be applied to either raw or processed film with or without gelatin backing.

Copies of PH1.31-1958 may be ordered at 80 cents each from American Standards Association, 70 East 45 St., New York 17.

Wide-Screen Motion Pictures Booklet

Wide-Screen Motion Pictures, a Society publication, has been revised and brought up to date. First issued in 1955, the booklet has been reprinted several times. In addition to up-to-date information on wide-screen processes, the new 16-page booklet contains a brief but informative article on "Principle of Anamorphosis," an article on "Magoptical Soundtracks," a list of relevant ASA Standards and a list of related SMPTE Test Films. In addition to the six processes described in the earlier booklet (Cinerama, CinemaScope, VistaVision, Superscope, Todd-AO, and Perspecta Sound), the new booklet contains data on Cinemiracle, M-G-M Camera 65, Panavision, and Technirama. Specifications are given in each case for such features as camera aperture, projector aperture, aspect ratio, anamorphic ratio, direction and rate of film travel, soundtracks, loudspeakers and screens. The new booklet is available from Society headquarters at a nominal charge.

The BBC Colour Television Tests: An Appraisal of Results, Monograph 18, is one of a series published by the British Broadcasting Corp. About six are published each year, each dealing with a technical subject within the field of television and sound broadcasting. Monograph No. 18 outlines the technical considerations involved in an adaptation of the American N.T.S.C. color system to the 405-line British standard and gives a statistical analysis of an extensive series of field tests. The authors, members of the staff of the BBC Engineering Div., are W. N. Sproson of the Research Dept., S. N. Watson of the Designs Dept. and M. Campbell of the Engineering Information Dept. The monograph is priced at 5s (70 cents) and is available from BBC Publications, 35 Marylebone High St., London, W.1., England. A list of previous monographs in the series is available.

SMPTE Lapel Pins. Gold and blue enamel reproductions of the Society symbol, with screw back. Available to all members from Society headquarters. Price $4.00 including Federal Tax; in New York City, add 3% sales tax.

85th Convention, Miami, May 4-8

An outline of Sessions of the Papers Program was given in the January *Journal* and in the Postal Announcement sent all members at the end of January. Well before deadline of February 16 for Author Forms and abstracts, several sessions are about filled and many prospects are fitted in throughout the program as this is released for press. The Equipment Papers Session on Tuesday afternoon bids fair to be a full and constructive attraction. Eight papers-demonstrations have already been planned as a result of the mailing to all Exhibitors in January.

The motion-picture program which enhances the papers sessions chiefly by opening each session with particularly chosen short films is being developed by James A. Moses, Army Pictorial Service, Washington, D.C.

At an organizing luncheon on February 9 at the Biscayne Bay Hotel, Miami, to discuss the arrangements for the 85th Convention, left to right: George Gill, Century Lighting, Hotel Arrangements Chairman; Henderson Beal, University of Miami, Associate Program Chairman; Reid H. Ray, SMPTE Convention Vice-President, of St. Paul, Minn.; and, Norman Bean, WTVJ, Miami, Chairman of the Local Arrangements Committee.

From the Convention Vice-President

Never before in the Society's convention experience has a location offered as many convention facilities and as much in vacation enjoyment as Miami Beach. Members of the SMPTE, their families and guests, will enjoy the advantages of a luxury winter vacation at low rates because, at that time, the Miami Beach hotels will be operating on a summer-rate schedule. More than a million and a half people enjoy the pleasant climate and vacation facilities of Miami Beach each year.

Convention headquarters will be at the world-famous Fontainebleau Hotel. Facing the broad, blue Atlantic, the Fontainebleau, guests will find, is unlike any hotel they have ever visited. A city within itself, it is built on 24 acres and boasts a swimming pool, beach facilities, cabanas, shuffleboard courts, tennis courts, formal gardens and plenty of areas for sunning.

In May, lowered rates at the Fontainebleau, will range from $14 to $22, especially for SMPTE members. Up famous Collins Avenue, just two blocks away, is the Montmartre Hotel, Miami Beach's newest luxury hotel. Just opened in February, the Montmartre has 300 modern rooms and all the facilities of the larger hotel. Rates range from $11 to $17. All rates quoted are for double or single occupancy. Reservations at either hotel should be accompanied by one day's deposit.

Your Convention Vice-President has inspected personally both hotels, and has recommended them highly. SMPTE guests will receive special attention.

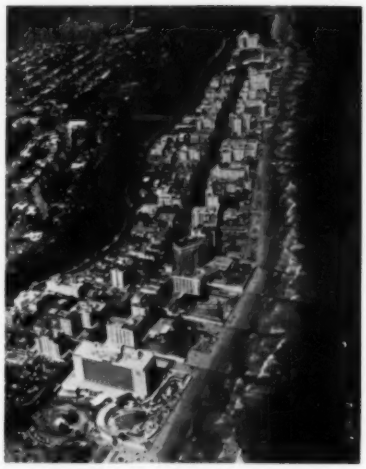
In addition to the Fontainebleau and the Montmartre, there are many hotels and motels, with varying price ranges, that are pleasant. One of the newer motels, only 5 blocks from the Montmartre and the Fontainebleau, is the Moulin Rouge. Early reservations are suggested at any of the Miami hotels, though, since the Society has contracted for a limited number of rooms, and the summer tourist business is heavy at the time of the Convention.

When the 85th Convention opens at the Fontainebleau, the Society will have the distinction of being the first organization to meet in convention sessions in a large new area of the hotel.

The Miami Hospitality Committee and the Ladies' Committee are planning official tours to points of interest. For the ladies, a boat trip to Vizcaya has been planned for one day, and a visit to the Parrot Jungle for another. For those who wish to spend more than the allotted time sightseeing, there will be many tours available.

The Miami temperature in May averages between 74 and 83 degrees with cool trade winds from the sea. Resort wear is cool, casual and comfortable and the ladies will find cottons, especially strapless or sunback models with little jackets, suitable for sightseeing, shopping and daytime sports. Men seldom wear dark business suits. Sport jackets, slacks and short-sleeved sport shirts are almost standard wear.

Those SMPTE conventioneers, who have enjoyed former resort conventions at Lake Placid, will be more than pleased and surprised at the attractions of world-famous Miami Beach. Make your plans to attend, and send in your advance hotel and convention registrations now.



The Fontainebleau is at the top of the photo — and the Montmartre, which was not built when this picture was made, is just to the north of it.

Local Arrangements

A hard-working group which makes a vital contribution to the success of each Convention is composed of Local Arrangements Chairmen, each of whom is responsible for a segment of Convention activity — some in fun departments, others overseeing such matters as registration and hotel arrangements, and each and all of them taking care of the myriad details that are concomitant to all Conventions. Local Arrangements Chairmen for the 85th Convention are:

Local Arrangements Chairman: **Norman Bean,** WTVJ, 316 N. Miami Ave., Miami.

Exhibits: **John B. Olsson,** Beattie-Coleman Inc., 1000 N. Olive, Anaheim, Calif.

Hotel Arrangements and Assistant to Exhibit Chairman: **George H. Gill,** Century Lighting Inc., Box 775, N. Miami.

Registration: **William Reddick,** W. J. German, Inc., John St., Fort Lee, N.J.

Publicity: **Burt Toppan,** WTVJ, 316 N. Miami Ave., Miami.

Banquet and Luncheon: **Spears Mallis,** WTVJ, 316 N. Miami Ave., Miami.

Auditor: **Arthur Hertz,** WTVJ, 316 N. Miami Ave., Miami.

Hospitality: **Edmund Reed,** Reela Films, 17 N.W. 3rd St., Miami.

Membership: **Earl Lewis,** WTVJ, 316 N. Miami Ave., Miami.

Projection and Public Address and Recording: **Larkin C. Webb,** 345 S.W. 27th Rd., Miami 36.

Ladies Program: **Mrs. George Gill,** 1477 N.E. 129 St., N. Miami.

Administrative Assistants: **Ralph Schneelock, Jr.,** Inter-American Equipment, 942 N.E. 1st Ave., Miami; and **Harold Hornstein,** Joe Hornstein Inc., 273 W. Flagler St., Miami.

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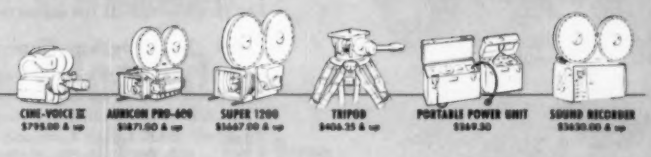

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International Equipment Exhibit

Expectations for a big and exciting exhibit are being fully justified, according to Exhibit Chairman John Olsson. In the first few days after the space was made available, at least 20 booths were snapped up and the main question John is waiting to decide is how soon he will need to arrange with the Fontainebleau for additional space. Among the companies with booths already definitely assigned are:

Animation Equipment Corp.
Benson-Lehner Corp.
Camera Equipment Co.
Century Lighting, Inc.
Electronic Applications, Inc.
Florman & Babb, Inc.
Houston Fearless Corp.
Kling Photo Corp.
Magnasync Mfg. Co.
Precision Laboratories
Ro-Nan Plastics & Mfg. Co.
S.O.S. Cinema Supply Corp.
Studio Supply Co.
Sylvania Electric Products, Inc.
Vicom, Inc.
Wollensak Optical Co.
Zoomar, Inc.

Other companies intending to be represented should lose no time in contacting John Olsson, c/o Beattie-Coleman, Inc., 1000 N. Olive St., Anaheim, Calif.

The new feature of this Exhibit, the afternoon of demonstrations and equipment papers scheduled for Tuesday, when exhibitors will be showing their products individually to the convention audience in the sessions auditorium, is also lining up fast. So far, reservations for time during this session have been made by Animation Equipment, to show the new Oxberry Unistand; Camera Equipment, to show a double-system magnetic portable sound recorder; Electronic Applications, to show a Model 140 (West German) reverberation unit with Nagra (Swiss) Recorder and Monitor Speaker; Florman & Babb, to show the Portman Animation Stand and the F&B Effects Stand; Kling Photo, to show new Arriflex 16 & 35 cameras and anamorphic lenses; and Wollensak, to show the WF4S 16mm 4000-ft Stop-Start Fastax Camera. Exhibitors who wish to include a demonstration or brief equipment paper in this session should send in their applications without delay to the Program Chairman, Garland C. Misener, 1905 Fairview Ave., N.E., Washington 2, D.C.

From the Program Chairman

Some of the titles received by Gar Misener well before deadline were:

"The Silicon-Controlled Rectifier Dimmer"
"A Multi-PAR Lamp Luminaire for Light Projection for Stage Lighting"
"New, Compact Light Source for High-Speed Photography"
"Photographic Instrumentation in the AVRO CF-105 Arrow"
"Production Planning for Contractual Film Progress Reports"
"Are ASA Speed Numbers Accurate?"
"New Approaches to Location Recording Techniques"
"Como Establecer y Mantener el Balance de Luz de Copia, Usando un Sistema de Azar Controlado, al Hacer Copias Aditivas en Color" (Establishing and Maintaining Printer Light Balance in Additive Color Printing by a System of Controlled Chance)
"A Comparison of Learning Resulting From Motion-Picture Projector and Closed-Circuit Television Presentations"
"Chemical Subtitling of Positive Film"
"Horizon Sag Compensation for Projection on Wide Screens"
"Gamma Insensitive Radiation Television Camera Lenses"
"A Program-by-Program Billing System for Pay TV"
"Adaptations of the Videotape Recorder for Foreign Television Standards"
"Bandwidth Increases in Videotape Recording"
"Transient Response Considerations in Videotape Recording"
"Recent Technical Developments in Television Recording on Magnetic Tape"

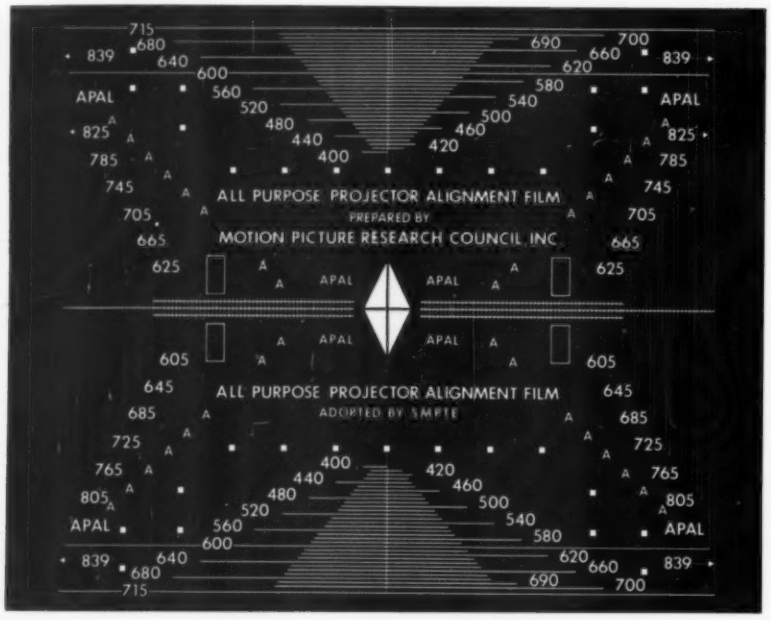
Committee Meetings

It is planned that most, if not all, committee meetings, except for engineering committees, will be scheduled for Wednesday afternoon, when no technical sessions are in progress. The nature of the standardization activity and multiple individual membership make it impossible to hold concurrent engineering committee meetings; however, the scope of activity of the committees will be taken into consideration and every effort will be made to assign meeting times so as not to conflict with the sessions relating to the interests of the committee members. All committee members will be mailed notices of the schedule of their meetings. All meetings are open and information about them is available from Society headquarters.

Education, Industry News

A new 35mm All-Purpose Projector Alignment Film, produced by the Motion Picture Research Council and adopted by the SMPTE, is now available from Society Headquarters.

The film consists of a basic target which is photographed directly on 35mm release positive stock. It is produced in the MPRC laboratories using a 35mm camera which was specially prepared with a projector aperture having the proper distance to the guided edge and equipped with positively aligned registration pins. The APAL camera original film may be used for checking all standard aperture sizes including the 0.715 by 0.839-in. aperture.



In addition to aperture determination, this film may also be used for testing height steadiness, side weave, travel ghost, focus, squeeze ratio and breathing and buckling. Further information concerning this film may be obtained from Society Headquarters.

A television-guided motion-picture camera system has been developed by Radio Corp. of America for visual exploration of the sun. Astronomers at a ground base, controlling the aim and focus of a telescope hanging from a balloon 80,000 ft above the earth, will be enabled to observe the sun, unhampered by the density and turbulence of the earth's atmosphere.

Next summer, from a base in Minnesota, a 12-in. reflecting telescope called the Stratoscope will be carried in a balloon to a point about 15 miles above the earth. A slow-scanning TV camera and a motion-picture camera, both mounted on the Stratoscope, will be linked by a mirror system. The images appearing in the reflector will be photographed by the motion-picture camera for a permanent record. The TV transmitter, also mounted

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on the telescope, will transmit to monitors at the ground base second-by-second views of what the motion-picture camera sees. The astronomers watching the monitors can control the aim and focus of the telescope by means of a remote control system which also is being specially developed for this project.

The TV camera (which measures 8 in. by 6 in. by 5 in.) the transmitter and battery supplies are protected by a pressurized case. A special antenna arrangement is contained in a shock-resistant foam package suspended below the telescope. In operation, a shutter arrangement will cause the telescope image to be reflected briefly, once each second to the television camera which will transmit to the ground, during the remainder of the second, a picture identical to that recorded at the same instant by the film camera. The system is being developed under the supervision of V. K. Zworykin by a group of scientists directed by Leslie E. Flory.

Almost a decade ago, Dr. Zworykin told the Society about these possibilities in a paper on "New Television Camera Tubes and Some Applications Outside the Broadcasting Field," presented in October 1949 at the Hollywood Convention. Dr. Zworykin said, "In speaking of the electronic stabilization of star images to compensate atmospheric and clock drive errors...we have been able to keep our feet on the ground. We shall now contemplate the possibility of placing our telescope in a balloon and ascending to heights where atmospheric refraction ceases to play an appreciable role. We will now need electronic methods to maintain the proper orientation of the telescope in spite of the uncontrollable motions of the balloon and, eventually, to send the star images back to earth," (*Jour. SMPTE, 55:* 227–242, Sept. 1950).

An American Film Festival sponsored by the Educational Film Library Assn., 250 W. 57 St., New York 19, will be held April 1–4 at the Statler Hotel, New York. Films will be grouped under the major headings of Education and Information; Cultural; Industrial; Religious; and Health and Medical. Sound and silent filmstrips and 16mm films will compete for awards in approximately 30 categories under the major headings.

The Inter-Society Color Council will hold its 28th Annual Meeting April 1, 1959, at the Statler-Hilton Hotel, New York. Guest speaker at the banquet, held that evening, will be Deane B. Judd of the National Bureau of Standards. Dr. Judd will describe experiences in the field of color and material color standards. A symposium on The Use of Material Standards for Color Matching will be held in the afternoon. The speakers are A. J. Benjamin, Monsanto Chemical Co.: Harry J. Keegan, National Bureau of Standards; and Hugh Davidson and Henry Hemmendinger of Davidson and Hemmendinger Co. Advance registration blanks may be obtained by writing Ralph M. Evans, Secretary, Inter-Society Color Council, Color Technology Div., Bldg. 65, Eastman Kodak Co., Rochester 4, N.Y.

The Society of Photographic Scientists and Engineers will hold its 1959 National Conference October 26-30 at the Edgewater Beach Hotel, Chicago. The Papers Chairman is Charles E. Ives, Kodak Research Laboratories, Rochester, N.Y. Exhibits Chairmen are Arthur E. Neumer, Carl Stauff and Richard Van Steenburgh. Local Activities Chairman is Nelson Rodelius and Conference Coordinator is Ira R. Kohlman.

T. Howard James, Research Associate of Eastman Kodak Research Laboratories, has accepted the post of Editor of *Photographic Science and Engineering* (the journal of the Society of Photographic Scientists and Engineers). He began his duties with Volume II, Number 3 of the publication. Dr. James was co-author with L. J. Fortmiller of "The Kinetics of Development of Vanadium Salts," (*Journal*, March 1954).

Resignation of Peter Hansell, editor of *Medical and Biological Illustration* since it was first issued in 1950, has been announced. The magazine, launched as an experiment eight years ago, is backed by British Medical Assn, and is contributing a unique service in the fields of medicine and biological sciences. The magazine's editorial board boasts an impressive roster of persons distinguished in their various fields. Among the overseas correspondents are Henry Lester, Photographic Consultant, 270 West End Ave., New York 23; and Lloyd E. Varden, Photographic Consultant and Assoc. Prof. in Graphics, Columbia University, New York.

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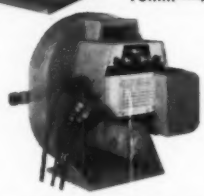

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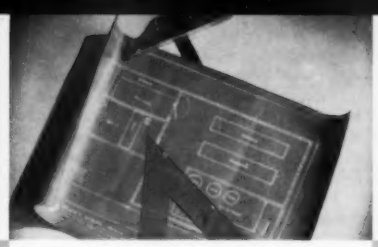

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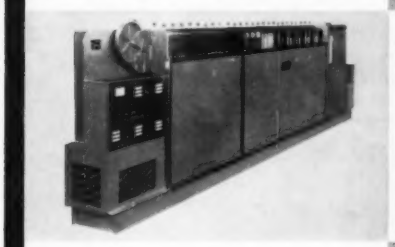

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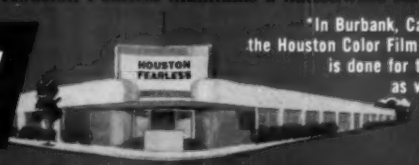

*In Burbank, California, Houston Fearless operates the Houston Color Film Laboratory where finest quality processing is done for the major motion picture studios as well as 16mm producers.

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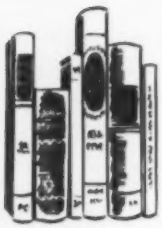

books reviewed

Operational Mathematics (2nd Ed.)

By Ruel V. Churchill. Published (1958) by McGraw-Hill Book Co., 330 W. 42 St., New York 36. ix + 337 pp. 6 by 9 in., Price $7.00.

This second edition, published under a new title, is an extensive revision of *Modern Operational Mathematics in Engineering*, published in 1944. It covers the properties and applications of the Laplace Transformation, the Fourier Transformation, and Eigenvalue problems, and, as the author states, is intended for use as the text for a basic course in operational methods at the junior or senior level and for an advanced course covering methods in partial differential equations.

The greatest part of the book, seven chapters out of ten, is given over to an extensive treatment of the properties and varied applications of the Laplace transformation. The mathematical development requires a background which includes advanced calculus, although several topics in advanced calculus are reviewed to provide the necessary background. There is also a chapter devoted to a review of complex variable theory which is necessary in extending the Laplace Transformation to complex numbers and in the material on Fourier transforms and Eigenvalue problems.

The applications discussed in the book require some knowledge of such topics as heat transfer, electrical circuit theory, and mechanics. The reader who has had at least a year of college physics, or the equivalent experience in practical engineering problems, should have little trouble in understanding the applications and interpreting the results. Although the important results are stated as theorems and are rigorously proved, those who are primarily interested in the engineering and physical applications will be able to appropriate the results of the theorems and spend little or no time on the mathematical proofs and derivations. Care should be taken in doing this, since in many cases it is necessary to understand thoroughly the conditions under which the results are reliable.

The comparatively advanced background required by this text is a severe limitation on its usage. Engineers who have the required background will find the book of considerable interest. The applications to the design of mathematical systems should be of interest to those concerned with design and analysis of such systems, and electrical engineers will find many applications to circuit analysis and servomechanism theory. Many other applications not specifically called out will also be readily apparent, and operational methods often provide a simplified means to problem solution.

The excellent bibliography found at the end of the book provides further references for those who are interested in a more detailed treatment of specific applications, and an extensive table of the common Laplace transforms is also included in the appendices.

In summary, this text should prove useful and interesting as a reference for those who are concerned with the design and analysis of electrical and mechanical systems. It is of extremely limited value to those who do not have at least a working knowledge of such systems and the necessary mathematical background.—*Harvey W. Mertz*, Philco Corp., 22 St. and Lehigh Ave., Philadelphia 32.

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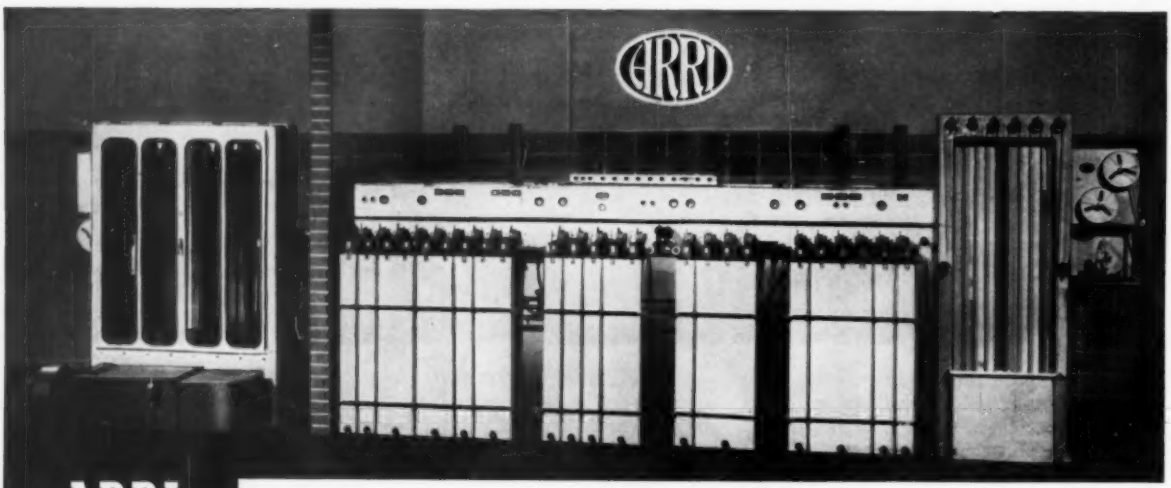

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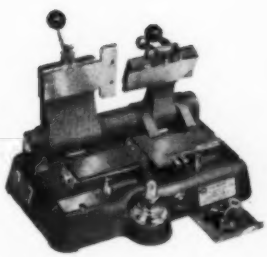

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section reports

The Chicago Section met on October 6, 1958, at the Prudential Plaza Building with an attendance of 57. Prior to the meeting an informal dinner was held honoring the speaker guests, Frank Carlson of General Electric Co., Cleveland, Ohio, and Frank White, Eastman Kodak Processing Plant, Chicago.

Of special interest was our opening film *The Factual Fable of Quality Freeze* produced by Paragon Pictures, Evanston, Ill. Filmed entirely on new Ektacolor Commercial Film, this production represented one of the first motion pictures completed on the new stock in the Chicago area.

Frank Carlson presented his paper entitled "Design Improvements in High Wattage Tungsten Filament Lamps for Motion Picture and Television Studios." This paper described a new collector grid for use in high wattage filament lamps which effectively maintains the beam lumen output of such lamps at a high level prior to filament failure. In the course of his discussion Mr. Carlson elaborated on the causes and effects of lamp blacking. Slides were used to illustrate these points.

The second paper "An Improved Tear Detector for Film Processing Machines" was presented by Frank White. The author described a device for detecting film stock defects and for automatically stopping the film transport while the break is repaired. The unit is suitable for use in total darkness and has proven useful in preventing costly losses due to film breaks during processing.

A brisk question and answer period followed the presentation of these two papers during which time both speakers answered questions from the audience.—*William H. Smith*, Secretary-Treasurer, Lakeside Lab., Box 2408, Gary 5, Ind.

The Dallas-Ft. Worth Section's meeting on November 13 had a very good attendance of 60. Three speakers presented papers as follows: H. Pope McDonald, Jam Handy Corp., "Engineering A Motion Picture"; Fred Buchholz, Kling Photo Corp., "Arriflex Equipment;" and Dallas Andrews, RCA, "Four-Track Tape Magazine System."

Mr. McDonald showed the many production problems which had to be solved by the Jam Handy Corp. when they produced their film *The American Engineer*.

Fred Buchholz demonstrated to the group the Kling Photo Corp.'s latest Arriflex camera equipment.

Dallas Andrews demonstrated RCA's new four-track tape magazine system.—*E. J. Pattist*, Secretary-Treasurer, 3618 Marsh Lane Pl., Dallas, Texas.

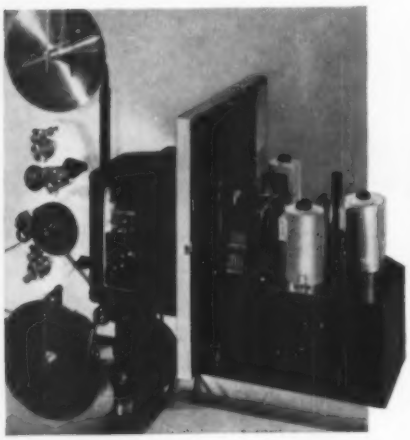
The Hollywood Section meeting of November 18th had an attendance of 93, to hear J. L. Berryhill, Chief Engineer, KRON-TV speak on "An Automatic Program Switcher for Television Stations"; and W. F. Schreiber, Technicolor Corp., speak on "Synthetic Highs—An Experimental TV Bandwidth Reduction System."

The meeting was opened with a 16mm sound color film *Ripple Rock*, which is the story of the removal of the navigational hazard in Seymour Narrows, British Columbia, by the largest single commercial blast ever set, using nearly 3 million pounds of Nitramex.

Mr. Berryhill described equipment designed to perform the switching operations during a television station break. This equipment permits the pre-selection of any one of ten inputs of both the video and audio switcher. It permits the start and stop of twelve projectors, tape recorders, and other equipment, and the positioning of multiplexor mirror tables or projector dousers. This automation of station programming is employed at KRON-TV in San Francisco.

The above mentioned paper by Mr. Berryhill won the Scott-Helt Memorial Award which is given by the IRE for the best paper written and published in the *Transactions* of the Broadcast Transmission Group.

Mr. Schreiber read the paper which he co-authored with C. F. Knapp and N. D.



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Kay, also of Technicolor Corp. The paper described a complete experimental system which codes a standard video signal to match a narrow-band channel and subsequently decodes the receive signal for display on a standard television monitor. The system transmits the low-frequency signal in analog form. The location and quantized amplitude of the edges are transmitted by a digital code. Bandwidth reduction is achieved by exploiting both statistical correlations and psycho-physical phenomena. The equipment for the separation of low frequencies, detection and quantization of edges, and synthetic reconstruction of highs was described. A 16mm kinescope recording of the pictures produced through this system was shown.—*Robert G. Hufford*, Secretary-Treasurer, c/o Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38.

The New York Section meeting of November 19 was held at the Carnegie International Endowment Center, New York City. An enthusiastic and interested overflow audience of 282 persons heard three papers related to the use of video tape. K. B. Benson and P. E. Fish of CBS presented a paper on the video-tape facilities at CBS-TV, New York City. L. Weiland of NBC read a paper on the color video-tape operations at NBC. These papers were followed by T. J. Merson of the Ampex Corporation who presented a paper "An Interim Report on the Splicing of Video Tape."

The paper prepared by Messrs. Benson and Fish was presented by Mr. Benson. This paper described the establishment and operation of the CBS video-tape recording center in New York City and outlined some of the problems relating to the construction of the space, installation of electrical circuitry, and the operation of 14 Ampex tape recorders. One of the major functions of this equipment will be the broadcasting of programs at a delayed time interval during the use of daylight saving time throughout the U.S. A series of slides taken during the installation of the equipment were projected.

L. Weiland of NBC described the history and background of the installation in Los Angeles of color video-tape recording facilities for NBC. A modified Ampex prototype machine was originally used and later RCA Camden equipment was installed. Color-television programs are recorded and played back at a later hour for West Coast consumption. Mr. Weiland outlined the techniques and problems they have experienced in this operation since 1957.

Mr. Merson presented a paper describing a splicer supplied by the Ampex Corp. for the handling of video tape. The splicing of the magnetic recording is made possible by the application of a ferrous compound in a binder which makes the magnetic recording visible. The actual splice is made at the vertical blanking line in the sync track.—*Edward M. Warnecke*, Secretary-Treasurer, c/o Eastman Kodak Co., 342 Madison Ave., New York 17.

The San Francisco Section met at the Stanford Research Institute, Menlo Park, on July 8 to hear Jack Kabell, Research Engineer, Video Systems Laboratory of the Institute give a talk on "The Insidious

Transistor." As transistors and other semiconductor devices appear in the new designs of audio and video equipment with increasing frequency, there is a tendency to view these unfamiliar intruders with some misgivings. Twenty-eight members and guests were present to hear Mr. Kabell shed some light on the mysteries of solid state electronics. He first described the theory of positive and negative carriers in the molecular structure of semiconductors and how these carriers were put to work in the transistor. Typical applications were discussed along with some interesting facts on the frequency range, power range and reliability of the devices. A simple transistorized audio amplifier and a regulated power supply were demonstrated to indicate the possibilities for "home-grown" equipment.

Before the meeting, the usual custom of getting together for cocktails and dinner was followed, this time at Hal's Restaurant in South Palo Alto.—*Rodger L. Woodruff*, Secretary-Treasurer, KRON-TV, 929 Mission St., San Francisco.

The University of Southern California Student Chapter report for the period July 1, 1957, to June 30, 1958, showed an increase of 34 new members in the Chapter. An attempt to raise money for the Chapter's treasury resulted in the sale of 43 copies of "Elements of Color in Professional Motion Pictures" which was selected as official text for the camera classes at the University.

Several field trips and other allied activities were successfully undertaken during the year. These included: a field trip to Sound Services, Inc., at the company's invitation, to watch the dubbing of a feature length motion picture; a field trip to ZIV Television Programs, Inc., at the invitation of Herb Strock, to watch the filming of part of one of his features; a field trip to the location of the filming of "Wild Bill Hickok" and "Rin Tin Tin"; assistance by student members in the projection of slides and 16mm films at the 83d SMPTE Convention in Los Angeles; a field trip to the Mitchell Camera Corp. to watch the manufacture of the Mitchell Camera; year-round assistance to the Hollywood Section by projecting slides and 16mm films whenever required at section meetings.

Four meetings of the Chapter also took place during this period. On March 14, 1958, the USC-produced film "Underwater Recreation" was shown, Dustin Rawlinson, producer. On March 28, 1958, the USC-produced film "On Seeing Film," based on footage shot during the filming of "The Bridge on the River Kwai," was shown, Dustin Rawlinson, producer. Don Norwood was the guest speaker at the April 25, 1958, meeting.

On May 29, 1958, the election of officers for the 1958 Fall Term were announced. Elected were Frank P. Clark, Chairman, and Karl F. Mylander, Secretary-Treasurer. Three "student-staff" meetings were requested for the fall of 1958, at which time the Student Chapter was to present semi-technical programs for all the students in the USC Cinema Departments. For the first of these meetings, it was decided to have an equipment exhibit on the sound stage for display of some of the local manufacturers' and distributors' equipment. Also planned were four member meetings and a full program of field trips. The Student Chapter also planned to continue to assist the Hollywood Section by projecting slides and films at its meetings.—*Dustin Rawlinson*, Chairman, University of Southern California Student Chapter, 1265 W. 25 St., Long Beach 10, Calif.

The Washington Section received some expert information on the workings of communications between the White House and the "outside" world at its June 11 meeting in the Treaty Room in the Executive Office Building of the White House. More than 100 members and guests gathered to hear the featured speaker, James C. Hagerty, Press Secretary to the President, talk on "The President and the Press." As a prelude to the meeting, several historic motion pictures were shown, including the first presidential press conference held by President Eisenhower and the conference in which he announced his intention to be a candidate for renomination for a second term. Mr. Hagerty's talk on the various problems confronting his office in connection with the dissemination of news included some serious and some humorous anecdotes which were well received by the audience. Following his talk, the Press Secretary remained to participate in the round table discussion which concluded the evening's program.

Capt. Robert Richardson, White House Signal Agency, discussed the problems peculiar to his agency concerned with the motion-picture and television dissemination of information from the President and how the Agency keeps up with all the latest forms of communication. The problems confronting a newsreel company in motion-

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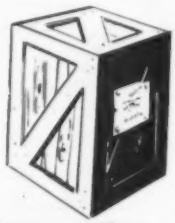
picture coverage of press conferences and other new events emanating from the White House were discussed by Charles Shutt, Washington Bureau Manager, Hearst Metrotone News and Telenews. The facts brought out in this talk served to call the attention of all present to the importance of motion pictures for news dissemination. Television broadcasting networks also have their problems in covering the highlights of the President's activities and particularly those of the press conference. Julian Goodman, Manager, News and Special Events, NBC Washington, spoke on these problems, especially those of an editorial nature facing the television news editors in avoiding charges of political bias or favoritism.

Jim Barker, Section Chairman, led the round table discussion which followed the speakers' formal presentations. The discussion was particularly animated and lasted over a half-hour. Mr. Barker and Al Moses were instrumental in arranging for this highly interesting meeting.—*Henry M. Fisher*, Secretary-Treasurer, 4003 Underwood St., Chevy Chase 15, Md.



new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

The stock of Altec Companies Inc. will be acquired by Ling Electronics Inc. under terms of an agreement announced by Board Chairman James J. Ling. Upon completion of the acquisition, Altec Companies Inc., together with its subsidiary, Altec Lansing Corp., will operate as subsidiaries of Ling Electronics Inc. Altec Service Co. will continue as a division of Altec Companies Inc. No change in the commercial operations, management, names or policies of the companies is contemplated.

A new 5-ft high Eidophor projector, weighing 800 lb was demonstrated in Washington, D.C., in December before the American Assn. for the Advancement of Science. The demonstration was sponsored by Ciba Pharmaceutical Products Inc., of Summit, N.J., backer of Dr. Edgar

Gretener A.G., the Swiss company which developed the Eidophor.

The Washington, D.C., demonstration added a new chapter to the Eidophor story. On the human side it has had a dolorous history. It was invented in 1939 by Fritz Fischer of the Swiss Federal Institute of Technology. Dr. Fischer died in 1947, before practical success of the invention was assured. Edgar Gretener, who continued the development, died last October.

Reaction to the Washington, D.C., demonstration was, for the most part, extremely favorable. An earlier demonstration in New York (New Products, *Jour.* p. 80, July 1952) was under the auspices of 20th Century-Fox. At that time a 30-minute program was originated and transmitted from a studio to a theater several blocks distant. Since that early demonstration, 20th Century-Fox and General Electric have jointly continued developmental activities. The Eidophor has been described in articles in the *Journal*, including "The Eidophor Method for Theater Television," E. Labin, pp. 393–406, Apr. 1950, and "The Eidophor System of Theater Television," Earl I. Sponable, pp. 337–343, Apr. 1953.

In the Washington, D.C., demonstration, pictures of a heart operation were shown in color on a screen 16 ft by 12 ft.

Ten Dage TV cameras have been spotted throughout Yale Transport Corp. Terminal, 40 St. and 12th Ave., New York, and connected by coaxial cable to monitors in the operations office to keep a 24-hour watch on loading and unloading activities. The TV system opens up new working space by eliminating the control tower which formerly occupied 500 sq ft of space and, at the same time, it permits closer management control. The dis-

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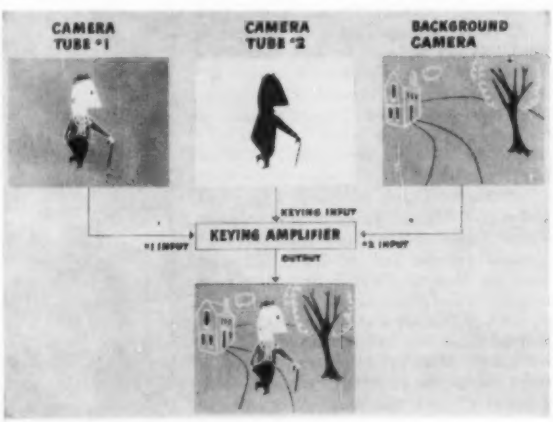
VideoScene, an electronic camera system which makes it possible to blend live action with miniature settings, still photographs or motion pictures, has been announced by the CBS Television Network Production Development Dept., 485 Madison Ave., New York 22. Two cameras are linked with a servosystem which synchronizes the cameras' movements so that background and actors are matched. One camera (with two tubes) covers the blank set on which the actors perform, while the other camera photographs the miniature background. The two pictures are blended into a composite on the TV screen.

A special reflective material, developed by Minnesota Mining and Mfg. Co., is used on the "blank" set. Through the use of a dichroic mirror the reflected keying light is transmitted to the camera where it becomes an optical signal. The effect of the reflected light is to "black out" the matting background against which the actors perform and permit the actors to be blended into the background setting. The process, at present, is applicable only to black-and-white, but it reportedly can be easily adapted to color.



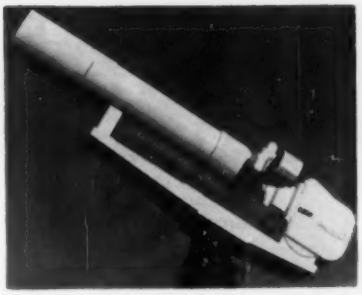
patcher, watching the monitor, directs traffic by means of a 2-way radio. The cameras (Model 63-A Dage) are secured to beams above the loading and storage areas. Completely self-contained units, the cameras adjust automatically to changing light conditions. Each camera measures $6\frac{3}{4}$ by $5\frac{1}{4}$ by $11\frac{3}{16}$ in. and weighs 10 lb. Each of nine cameras covers from four to eight of the terminal's 43 truck bays. The tenth camera, centrally located, is remote-controlled by the dispatcher who can point the camera in any direction and select any one of four lenses to achieve close-up shots of areas not completely covered by the fixed cameras.

A giant projection lens, more than a foot long and almost a foot in diameter and weighing 65 lb, has been installed at the New York Stock Exchange's Wall Street headquarters by Bausch & Lomb Optical Co., Rochester 2, N. Y. With the new lens, data on the standard $\frac{3}{4}$-in. tape can be projected 106 ft across the Exchange floor onto a large wall screen. The individual letters and figures are two feet high and the section of tape is magnified to 14 ft long. The lens has a focal length of 38 in. with an $f/4$ speed. It is designed to compete with the intense sunlight that usually streams through windows high above the Exchange floor and to provide a sharp image under adverse conditions.

Three types of projectors are described in a brochure available from Technical Service Inc., 30865 Five Mile Rd., Livonia, Mich. The Teclite projects to a screen in darkened areas and is suitable for audiences up to 1000. The Duolite features a built-in fold-away screen and does not require a darkened room for adequate projection. The Moviematic features a continuous magazine which eliminates rewinding and rethreading.

Hypervelocity instrumentation for missile and space research has been developed by Avco, Research and Advanced Development Div., 201 Lowell St., Wilmington, Mass, to measure shock waves, flow patterns and other events occurring at high Mach numbers in shock tubes and on ballistic ranges. One type of installation is the shadowgraph used on the ballistic range. The basic system employs a spark-gap point-light source, a collimating lens, a catadioptric light screen, an objective lens, and a photographic plate. A projectile is fired between the two lenses in the collimated light beam. When the projectile is at the center of the optical field it passes through a catadioptric light screen, a sensitive device used for detecting the presence of the projectile. A photomultiplier in the light screen sends a signal through a video amplifier to a trigger unit which triggers a pulse generator. The pulse generator provides a high-voltage pulse which makes the action of the light source and a Kerr Cell photographic shutter mutually synchronized with the position of the projectile. The whole action takes place with a "jitter" of less than 0.1 μsec.

A fixed focus as well as a focusing version of the 40-in. $f/8.0$ Cyclotar lens has been mounted on Hulcher rapid-sequence



cameras and is available through Gordon Enterprises, 5362 N. Cahuenga Blvd., North Hollywood, which designed the mount and cradle used to adapt the lenses

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CTM MORIGRAF—35MM—3 Kinoptic Lenses —100 Ft. Spring Wind—Focus Thru Film Or Gd. Glass—Spring Loaded Turret	695.00
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A powerful xenon lamp which produces approximately 500,000 lm and is said to have a life of over 500 hours has been introduced by Macbeth Corp., Box 950, Newburgh, N.Y. Called the XOO 20KW, it is a tube of drawn quartz, 72 in. long and approximately 2 in. in diameter. Manufactured by Osram Co. of West Germany, in operation it is a nonpulsed arc-type lamp which requires no forced air or water cooling and operates on 210-v, 60-c, single-phase power, with a simple igniter and choke. Features include instant start, ability to operate over a wide range of electrical current loads with no variation in the color temperature of the light. The internal pressure of the lamp is reported as slightly less than one atmosphere, which would eliminate danger of explosion. The company plans to make available, early in 1959, two smaller lamps, the 6KW (36 in.) and the 10KW (48 in.). Plans include offering a pair of XOO 6KW complete with auxiliary equipment such as stands and reflectors at a price of approximately $2000.00.

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to the cameras. Special features are a center of gravity balanced cradle with ¾ in. tripod insert, and a reflective white enamel finish to provide temperature compensations for use in direct sunlight. Also available are sun-hood extensions and specially mounted filters.

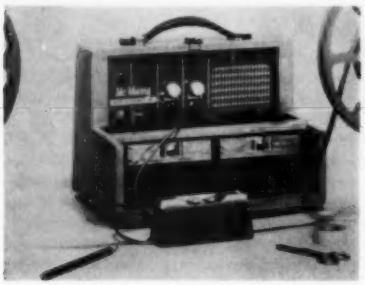
A broadband translator amplifier, Type RA-7, has been introduced by Adler Electronics Inc., One Lefevre Lane, New Rochelle, N.Y. The amplifier is said to provide 100 w of peak visual output power in 470–890 mc frequency range when driven by a suitable modulated UHF TV signal. Features include variable bandwidth, full metering, and a self-contained power supply.

The Fisher FaX-Ray Processor has been introduced by Oscar Fisher Co., Newburgh, New York. The unit, which operates automatically, develops, fixes, washes and dries x-ray film of all sizes, including 14 by 17 in. Processing time is only seven minutes. Film is developed by an agitation-immersion method, and washing time is reduced by use of a spray-through-air system. Approximate dimensions are: length, 6 ft; height, 7 ft; width, 4 ft; and weight about 500 lb. The price is $15,000.00.

A transistor tester, capable of checking the performance of transistors while they are connected within their circuits has been announced by Philco Corp., Philadelphia. The tester was developed under a contract with the Navy's Bureau of Ships, but it is expected to become commercially available in the near future.

A three-dimensional technique for studying moving air pockets that deviate light rays and interfere with aerial and long-distance photography has been developed by Eastman Kodak scientists. The air pockets are from 4 in. to 6 ft in diameter and have a refractive index different from that of the surrounding air because of

a slight difference in temperature. The studies are being conducted at Canadice Lake, N. Y. To observe the action of the air pockets, two high-intensity light sources, each polarized with a filter, were focused across the lake on a rear-projection screen at a distance of 1.3 miles. An observer, wearing a pair of spectacles like those once used to view 3-D motion pictures, stood behind the screen and watched the pattern of shadows in motion, as each of the light sources produced a shadow of an air pocket in different places on the screen. The 3-D glasses enabled the observer to "look into" the space between the screen and the light source and to judge the distance of each pocket from the screen.



The Model 58 Magnetic Reader has been announced by McMurry Audio Electronics Inc., 9740 Washington Blvd., Culver City, Calif. Designed to simplify sound-on-film editing, the unit separates sound editing from picture editing equipment. The device consists of a reading head plus an amplifier unit. The reading head, measuring 1¾ in. by 2½ in. by 5½ in., is connected by a flexible electrical cable to the main amplifier unit which is contained in a carrying case complete with loudspeaker. The amplifier unit, measuring 6 in. by 9 in. by 13 in., contains two sound input jacks. Dual-track editing can be performed by adding a second reading head. Interchangeable guides are available to accommodate 16mm magnetic film with either center or edge track.

Magnetic film, tape recording and reproducing equipment is described in a brochure available from Stancil-Hoffman Corp., 921 N. Highland Ave., Hollywood 38. The units described in the catalogue are designed around both vacuum tube amplifiers and transistor amplifiers to cover single- and multitrack recording for professional, stereo, instrumentation, and communications purposes.

The Broadcast Camera Equipment Catalogue (3rd ed.) has been issued by the Radio Corp. of America. Included are descriptions of color and monochrome cameras, accessories, lighting equipment and mobile units for TV station and closed-circuit use. New equipment described in the catalogue includes the TK-15 Studio Vidicon Camera, color and monochrome orbiters, color mobile unit and a number of optical accessories. The catalog is priced at $1.00, available from Radio Corp. of America, Broadcast and TV Dept., Front and Cooper Sts., Camden 2, N.J.

Fifteen Years of Semiconducting Materials and Transistors is a bibliography compiled by N. L. Meyrick of the Research Library, Newmarket Transistor Co., Exning Rd., Newmarket, England. The bibliography is revised and expanded from an earlier publication. General subjects covered include: Semiconductors — Theory and Measurements; Processing of Semiconductors; Rectifiers and Diodes; and Transistors. The 75-page bibliography contains 2511 references, more than twice the number of references contained in the first edition (which covered ten years), published four years ago.

A new publication, *Optics Plus*, has been announced by Perkin-Elmer Corp., Norwalk, Conn. To be published quarterly, it will report on developments in precision optics and instrumentation, including the fields of optical tracking, military infrared and aerial reconnaissance. The first issue described giant missile tracking cameras and alignment devices for inertial guidance systems in use at Air Force Missile Test Ranges. Another article described a sun-telescope camera designed for Project Stratoscope.

Perutz 8mm and 16mm black-and-white film is distributed in the United States by Burleigh Brooks Inc., 10 W. 46 St., New York 36. The film, which is manufactured in Germany, is supplied in speeds of 17, 21 and 27 DIN, which corresponds to 25, 100 and 400 ASA.

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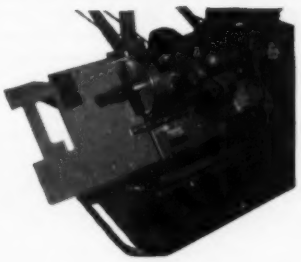

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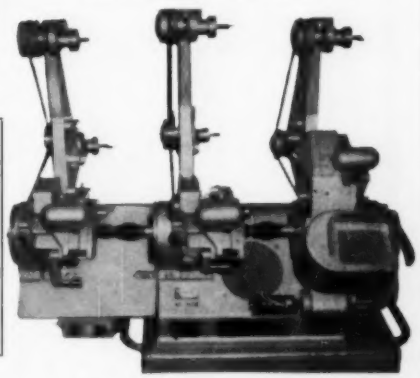

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Your Key to Quality Film Services is a brochure available from Geo. W. Colburn Laboratory Inc., 164 North Wacker Dr., Chicago 6, which describes the creative and technical services offered by the film. The brochure is illustrated by photographs taken in the plant.

An article on "Photography and Radar" in the December 1958 issue of the *Recorder*, published by Flight Research Inc., P.O. Box 1-F, Richmond, Va., is announced as the first of a series "to record general principles and later the details of specific applications." The publishers express the hope that the "articles will provide a useful " 'primer.' " The current article is clearly and concisely written and sets a high standard for the series.

New products announced by the firm include 35mm Model IV E multidata camera, a development of Model IV C with an auxiliary data chamber which records supporting and supplementary data directly on each film frame, and a new variable shutter for Model IV C.

The Pacific Northern Sales Div. of Eastman Kodak Co. is housed in a new building at 3250 Van Ness Ave., San Francisco, which was officially opened Nov. 10. The building contains sales and distribution facilities, including a technical service department for sensitized photographic products.

An instruction manual on close-up photography, including macrophotography, photomicrography and microphotography is available without charge from Standards Camera Corp., 319 Fifth Ave., New York 16. Profusely illustrated with photographs and drawings, the manual explains proper use of equipment (the Praktina and Praktica cameras) and contains charts and tables to provide helpful information.

Kodak Handbook News, replacing *Kodak Photo Notes* and *Kodak Professional Notes*, in the loose-leaf series, offers instruction in the use of Kodak products and advice as to how to achieve the best results. The current brochure (Periodical No. L-2-58-4-SH) on the subject of color slides from Kodacolor negatives is available from Kodak dealers.

An 81-page booklet by General Electric, describing all categories of audio equipment, from Audiomatic limiting amplifiers to Zipper-laced custom audio systems, has been issued by General Electric Technical Products Dept., Section P8, Syracuse, N.Y. The booklet is available without charge but because of limited quantities copies will be reserved for audio engineers and professional broadcasters on a priority basis.

Hagerstown's five-year plan has been advanced by the acquisition of an Ampex Videotape Recorder for use in classroom instruction as part of the experiment in television teaching conducted by the Washington County, Maryland, School System on a five-year basis. The machine uses magnetic tape developed by Minnesota Mining and Mfg., St. Paul, Minn. The recorder is expected to have several educational advantages such as interchange of lessons among school systems using TV teaching methods; saving important lesson presentations for future use; and recording events appropriate for classroom use.

Mincom Division of Minnesota Mining and Mfg. Co., 2049 S. Barrington Ave., Los Angeles 25, has announced contracts with Rome Air Development Center of Air Research and Development Command and Sandia Corp., Albuquerque, N.M., for video band instrumentation tape recording systems. An outgrowth of the former Electronics Div. of Bing Crosby Enterprises, the Los Angeles concern is engaged in research and development of video tape recording and instrumentation tape recording systems.

A laboratory model of a small, portable television tape player has been constructed at RCA Laboratories by a team of scientists under the direction of H. F. Olson, Director of Acoustical and Electromechanical Research Laboratory, Princeton, N.J. The experimental model is said to be capable of reproducing tape-recorded black-and-white pictures and sound through a standard television receiver with a degree of resolution and picture quality comparable to those of direct broadcast reception. Work is now proceeding on a compact recording attachment which will enable the unit to pick up as well as to reproduce program material in a portable system adapted to field pickup use.

On Splicing Videotape, a brochure issued by the Professional Products Div., Ampex Corp., 934 Charter St., Redwood City, Calif., gives step-by-step instructions for the proper use of the Ampex Videotape Splicer (*Journal*, Oct. p. 715 and Nov. pp. 730–733). The instructions picture and explain how to load the tape developer pen, how to load the splicing tape and how to use the splicer. An experienced operator is expected to accomplish the entire operation in less than a minute. Two different methods of locating the spot where the cut should be made are explained. The choice of method will depend on the preference of the operator and/or the character of the job. One method is similar to that used in editing audio tape. When this method is used, the operator simultaneously turns the supply and takeup reels by hand so the tape can be moved past the audio head until the proper spot on the soundtrack is located. The second method for locating the splicing area is to watch the TV monitor and stop the machine the instant the desired scene comes into view. Certain precautions are explained, such as the importance of keeping magnetized objects away from the recorded magnetic tape.

Applications of Ampex VR-1000 Videotape Recorders are described in an illustrated brochure issued by the Professional Products Div., Ampex Corp., 934 Charter St., Redwood City, Calif. Among the applications described are remote recordings in wind-tunnel test operations, radiation areas, rocket and missile launchings; re-

cording from guided missiles and explosive or volatile tests; educational television; recording in hospitals; radar and data recording.

An illustrated audio-visual equipment catalogue, No. 59, describing an expanded line of products is available from the Harwald Co., 1245 Chicago Ave., Evanston, Ill. The firm's equipment includes film inspection machines, splicing equipment, sound projectors, film and disk storage cabinets, film cleaning and conditioning solutions, recording tape and other items.

A rapid 35mm processor has been announced by Industrial Products Div., Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, L.I., N.Y. Designed to operate under daylight conditions and to use any size spool, it is reported to operate at speeds up to 6 ft/min with 400 ft of film processed at one loading. Called the Mini-Rapid 35, the processer weighs 120 lb and is 15 in. deep, 13 in. high and 37 in. wide. The unit is designed around a plastic drive insert in each solution tank which transports the film and at the same time provides solution agitation and squeegee action. The firm's Mini-Rapid 16 was made available earlier.

The FA-100M, a spray-processing machine for black-and-white film, has been announced by Hi-Speed Equipment Inc., Artisan Industries, 73 Pond St., Waltham 54, Mass. Features include combination operation which permits 16mm or 35mm film to be run successively without adjustment or conversion, continuously adjustable speed, a 15-min warm-up time, remote dial thermometers to indicate temperature of developer, hypo and wash water, air squeegees to prevent mechanical abrasions, impingement drying, and a built-in water blender which mixes a total of 2½ gals per min to the desired processing temperature. Power requirements are 30 amp, 208-v, 3-phase, 60-c. Dimensions of the daylight end of the machine are 8 ft long, 30 in. wide and 6 ft high. The dark end is 46 in. long, 24 in. wide and 5 ft high.

The TCR-1, a temperature-compensated red filter which provides a constant cutoff in temperature up to 80 C has been announced by Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N.Y. The filter was developed for use in color motion-picture film printing to overcome the disadvantages of the shifting of a red filter in response to temperature changes. The temperature-compensating feature is obtained by cementing on the inside with a thermosetting cement a multilayer interference coating to a light-colored red glass 3mm thick. The present filter is 55 mm in diameter and the coated or usable area has a minimum diameter of 49 mm.

An air squeegee for 16mm and 16/35mm film has been announced by Filmline Corp., Milford, Conn. The squeegee is designed for low-pressure operation to provide a cushion of air support as the film passes between the rollers so that, under normal use, the emulsion does not touch the rollers. An adjustable gap allows splices to pass freely. The 16mm model is priced at $55.00 and the 16/35mm model is priced at $68.00. Oil-Less Rotary Air Compressors with motors are offered to operate one 16mm, three 16mm or one 35mm, or six 16mm or two 35mm squeegees, priced at $187.50, $245.00, and $397.00, respectively.

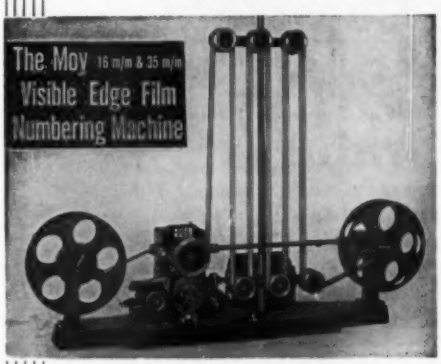
Use of a new vinyl-based dampening compound has resulted in a weight reduction of Altec multicellular horns by a ratio as high as 4 to 1, as announced by Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif. For example, the type of horn formerly weighing 250 lb now weighs only 80 lb. The horns are constructed of metal cells and are available in various cell sizes and configurations of 8 to 18 cells. Exterior surfaces are covered with the dampener to eliminate internal resonance and ring. The horns may be used with Altec 288B, 290C, or 730A driver loudspeakers in one- or two-way speaker systems.

An electromechanical transducer or loudspeaker, rated for continuous operation at sound pressure levels up to 166 db of random noise and up to 170 db at discrete frequencies, has been developed by Avco Research and Advanced Development Div., 201 Lowell St., Wilmington, Mass. The device was specially designed for acoustic noise testing of missile and rocket components and systems to military specifications. It is an electromagnetic unit with a moving coil which has a diameter of 12 in. The heart of the unit is the plastic and fiber glass reinforced moving coil diaphragm assembly which is suspended by U-shaped beryllium-copper springs from the electromagnetic housing. The acoustic energy produced by the diaphragm is focused and sent through an expanding horn to an opening, 4 in. in diameter, in the speaker structure. In testing operations, the noise generator is used with a progressive wave tube or reverberant chamber. The unit is 35 in. high, 24 in. long, and 26 in. wide. The random noise input power is 3 kw. The frequency range is 20 to 2400 cycles with a nominal impedance of 2 ohms.

A new whiteness reflectometer has been designed by Hunter Associates Laboratory, Inc., 5421 Brier Ridge Rd., McLean, Va., to measure the whiteness, reflectance, yellowness and opacity of white and near-white paints, papers, textiles, ceramics, foods, plastics and soap products. It can be equipped with an ultraviolet absorbing filter which may be alternated between the incident and the viewing light beams to measure directly the contribution of the widely used fluorescent brighteners to specimen whiteness. The instrument uses paired vacuum tubes in a null Wheatstone bridge circuit. It employs a 45°0° geometry and has green and blue tristimulus filters each with a separate pair of phototubes. The firm has also announced a digital-dial Color and Color-Difference meter designed primarily to detect small color differences in industrial products.

Identify Films Instantly!

Unnumbered films cause confusion and loss of time



Among the Many Purchasers Are

Walt Disney Productions, Burbank, Calif. (6 machines)
Eastman Kodak Co., Rochester, N. Y.
General Film Labs., Hollywood, Calif.
Reeves Soundcraft, Springdale, Conn.
American Optical (Todd-AO), Buffalo, N. Y.
District Products Corp. (Audio Devices, Inc.) Conn.
University of Southern California, Los Angeles, Calif.
Telefilm, Inc., Hollywood, Calif.
Consolidated Film Labs., Ft. Lee, N. J.
Eagle Labs., Chicago, Ill.
Cinerama Productions, New York
Columbia Broadcasting System, New York
Louis de Rochemont, N.Y.C.

The MOY edge numbers every foot of 16, 17½, 35mm film and simplifies the task of checking titles and footage

You can now save the many man hours lost classifying films without titles. The MOY VISIBLE EDGE FILM NUMBERING MACHINE replaces cue marks, perforations, messy crayons, punches and embossing—does not mutilate film. Work prints showing special effects, fades and dissolves require edge numbering to keep count of frames cut or added. Both negative and positive films can be numbered. Multiple magnetic tracks in CinemaScope stereophonic recordings make edge numbering a MUST. Write for illustrated brochure.

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Western Branch: 6331 Hollywood Blvd., Holly'd 28, Calif.

A series of tuneable Magnetron R-F Supplies from S through K_a bands, particularly suited for use on antenna pattern ranges and other applications where a pulsed magnetron source is required, is manufactured by California Technical Industries Div. of Textron Inc., 1421 Old County Rd., Belmont, Calif. Each Supply is divided into three units, a modulator, an r-f source, and an optional remote control unit to permit control from any direction. Typical specifications for the r-f sources are — X-band: type 2J51 magnetron; tuneable, 8500 to 9600 mc; 35-kw nominal peak power. S-band: 2J66 magnetron; tuneable, 2845 to 2905 mc; 15-kw nominal peak power. Other units are tuneable where tuneable magnetrons are available.

An underwater housing designed especially for Bell & Howell Filmo and Eyemo cameras features large front and rear port to simplify viewing and make it easier for the photographer to keep the camera on target. A product of Sampson-Hall Co., the housing is distributed by Gordon Enterprises, 5362 North Cahuenga Blvd., North Hollywood, Calif.

A new Ready-Eddy 8/16 film computer, a companion to the original 16/35 device is available from Ready-Eddy, Sandy Hook, Conn. The computers show screen time for a given footage, length of the film or scene for a given period of screen time, number of frames required for a certain action or effect and similar information. Ranges are from $\frac{1}{2}$ ft to 1638 ft and from 1 sec to 45$\frac{1}{2}$ min. The computers are priced at $2.95.

The Kodak Minicard System, a high-speed information system which combines the advantages of microfilm, punched cards, and digital computing techniques, has been developed by Eastman Kodak Co. Some components of the system were developed by Magnavox Corp. The system records documents, pictures or other information electronically on a film area about the size of a postage stamp. Through the use of electronic controls any desired information can be obtained by searching the records automatically at speeds which would correspond to evaluating 1000 such records per minute. Documents or other information together with identifying code signals are contained on each film record and each record may include up to 12 legal-size documents at a reduction ratio of 60 to 1. When the specified record has been found its contents may be examined at full size on a reader. Duplication of the records or of full-size paper prints may be made automatically.

More than 75 books on motion-picture and TV subjects are described in the current book list of Mole-Richardson Co., 937 North Sycamore Ave., Hollywood 38. Most of the books have been reviewed in the *Journal*. The list gives a brief description of the contents of each book together with the price. The company's current catalogue, Catalogue G, contains illustrations and descriptions, including specifications, of specialized lighting equipment produced by the firm. A separate price list is included in the catalogue.

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Audio-Visual Production. Freelance experienced in all phases of audio-visual production wants assignments on West Coast. Fully equipped for 35mm slidefilms, slides and 16mm motion-picture production; also equipped for editing. References available. Write: J. S. Paul, c/o J-Me Films, P.O. Box 6143, Bakersfield, Calif.

Theatre Sound and Projection Technician, 37, married, seeks position with Canadian theatre supply company. Experienced in installation of theatre projectors and some theatre sound and p.a. systems, maintenance of Simplex and other projectors, sound work on Ballantyne and other sound systems; first class B.C. projectionist since 1949 (in projection 13 yrs); qualified TV service technician, have built own test equipment including VTVM, signal generator, oscilloscope, complete television receiver and miscellaneous electronic test equipment. Employed as projectionist by Famous Players Canadian Corp. since 1950; seeks position that will further utilize qualifications; willing to relocate anywhere in Canada. Write: A. P. Mulcahy, 604 Nicola St., Kamloops, B.C., Canada.

Industrial Photographer, cameraman, producer. Broad experience: still and motion pictures production; camera, editing, darkroom b&w and color printing and processing, transparency duplication. 18 yrs working practice in industrial, commercial, educational, scientific, medical and documentary films. Good knowledge of production and use of audio-visual media. Presently working as production supervisor for a large color lab, but finishing agreement and available on short notice. Good background, master's degree; ambitious and reliable personally, Spanish language; able to manage production unit, design and organize a photo dept. Have some equipment, will relocate. Write M.G., 68-46 Groton St., Forest Hills 75, N.Y.

Motion-Picture Production, Presentation. Energetic, versatile, age 26. Thoroughly experienced in all technical phases of motion-picture production, 16 & 35mm, including formulation, writing and editing of scripts for TV commercials, educational, industrial, R&D and public relations films. Work experience includes: Prod. Asst., Elliot-Unger-Elliot Motion Picture.

and TV Commercials; Coordinator, Audio-Visual Dept., Univ. of Miami; just completed 2 yrs military service, U.S. Army Ord. as motion-picture director, technical writer and cinematographer. Productions distributed internationally. "SECRET" clearance, U.S. Army Ord. Eduction: BBA degree, supplemented by courses in electronics, education, technical writing, journalism and composition. Willing to relocate. Resume on request. Available for personal interview with films and scripts. Larry Ross, 55 Payson Ave., New York 34. Williams 2-0560.

Motion-Picture Cameraman, Technician. Active member SMPTE now employed at medium market TV station photographing, processing and editing news and commercial 16mm footage. Owner of two motion-picture cameras, lenses, tripods, lights, etc. Desires connection with producer of industrial, scientific, educational, religious or travel films. Available on 30 days notice. Résumé on request. Frank E. Sherry, 915 Mockingbird Lane, Tyler, Texas. Tel: LYric 3-4337.

Electronic Engineer. Television Major, B.S.E.E., age 28, vet, 4 yrs military electronics and radar and 1 yr TV experience, specializing in broadcasting and recording. Knowledge of color and microwave systems. Competent in magnetic, photographic and kinescope recording. Thesis written on magnetic video tape recorders. Desires position in motion-picture sound or TV studio engineering. Civilian or military projects. Foreign or domestic assignments. Fluent in German. Excellent references. Available June 5, 1959. Andis Lepnis, 5401 So. Ellis Ave., Chicago 15, Ill.

Chemical Engineer. B.Ch.E. Clarkson College of Technology, Potsdam, N.Y., Sept. 1958. Desire position in production or pilot plant. Write: Robert H. Cleveland, 732 Parsons Rd., Ridgewood, N.J.

Motion-Picture Engineer. 25 yrs responsible positions in large organizations. Expert in all technical phases motion-picture laboratory color or B&W. 2 yrs as technical director and sales engineer for representative of well-known motion-picture equipment. Motion-picture consultant to U.S. Govt. agencies in Washington. Will accept responsible position supervising laboratory operations in management, quality control, install new laboratories, etc., or as technical sales representative for motion-picture equipment. Will consider most sections of U.S. or certain overseas assignments. Excellent knowledge of three languages. U.S. citizen. Write: E.C.C., First Floor, 219–47 74th Ave., Bayside 64, L.I., N.Y.

Film Specialist. 3 yrs as animation cameraman; 2 yrs on optical camera; 5 yrs film editor and cameraman on commercials and industrials; produced films for Signal Corps at Astoria, also writer-director for A.F.R.S.; B.A. in Cinema, UCLA; member IATSE, Local 659. Familiar with every job concerned with production of motion pictures on professional level. Presently employed but desire change. Age 32, married. Good bet for ad agency, teaching or production. Have knowledge, will travel. Write: E. E. F., P.O. Box 19783, Los Angeles 19.

Electrical Engineer. Long experience design and maintenance all types electrical equipment in motion-picture studios, exchanges and laboratories. Many yrs chief electrician Paramount Pictures Corp., New York. Will accept position preferably New York area. Member SMPTE, IAEI. Fred F. Stederoth, 41 Watsessing Ave., Bloomfield, N.J. PIlgrim 3-2699.

Positions Available

8mm Movie Design Engineer, Production Engineer, Development Engineer. These are specific openings in our 8 mm movie program. Applicants must be graduate engineers with experience in engineering and manufacturing amateur motion-picture equipment. These openings are the result of a strong new products program at Argus Cameras and offer a rare opportunity to use your past experience in the motion-picture field with a growing and progressive company. Send resume to Employment Manager, Argus Cameras, Ann Arbor, Mich., stating age, education, work history and salary requirements.

Laboratory Control. Philadelphia motion-picture laboratory wants young man. Will have complete responsibility for mixing and sensitometric control of B&W processing chemicals and mechanical maintenance of Bell & Howell printers including balancing of exposure lights. Chemical and mechanical background plus knowledge of motion-picture laboratory techniques required. Send reply to Louis W. Kellman, 1729 Sansom St., Philadelphia 3, Pa.

Photo Engineer. Experienced in motion-picture and still production, high-speed, metric color and black-and-white; able to direct complete production unit including labs, motion-picture and still, writers, photography, editing. Applicants should have education and experience to assume heavy project responsibility.

Laboratory Supervisor—Motion Pictures. Assume complete responsibility for lab operation including developing, printing, quality control, black-and-white and color.

Laboratory Supervisor—Still Lab. Assume complete responsibility, still lab, black-and-white and color. Cameraman, Engineering. High-speed, engineering test films. Experienced Fairchild, Fastax, Traid, Bell & Howell.
Applicants for above positions should be willing to relocate. Write for appointment, including resume, to: P.O. Box 189, Times Square Station, 340 West 42 St., New York 36.

Senior Optical Engineer. Direct development proprietary line of high-speed cameras and other photographic instruments. Must have analytical ability and research or development experience with optical devices or photographic instrumentation; able to plan and carry out projects from inception through prototype stage. Position carries full technical responsibility and should be attractive to qualified applicants with managerial potential. Salary open. Advanced degree desirable. Plant located in pleasant suburban area near San Francisco. Contact George Bingham, Beckman & Whitley, Inc., 973 E. San Carlos Ave., San Carlos, Calif.

Theatre Sound Engineer. Cinefones, Bombay (India), requires theatre sound engineer with good technical qualifications, thoroughly experienced in installation, repair and servicing all types of theatre projection and sound equipment, and with administrative experience. Send complete resume airmail to Cinefones, 3 New Queen's Rd., Bombay 4, India.

Salesman, experienced, excellent opportunity motion-picture equipment and accessories organization. Comprehensive Service Corp., 245 West 55 St., New York 19.

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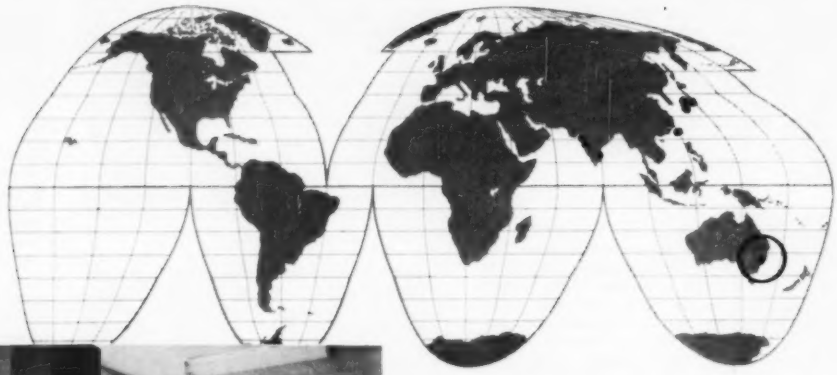

sydney (Australia)

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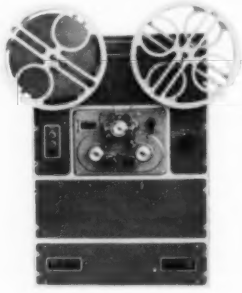
Montage at left shows part of the complete systems installation . . . 35 mm and 16 mm recorders, dubbers, electrical interlocks, mixing consoles and the Artransa mobile unit.

Photos of Artransa's key personnel are, starting at the top: John Appleton, director of sound recording; Alan Allen, chief recordist; Chris Offner, maintenance engineer, Lachlan Allman, chief projectionist.



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Meeting Calendar

American Physical Society, Mar. 6, 7, Univ. of Texas, Austin, Texas

Electrical Engineers Exhibition, Mar. 17–21, Earls Court, London.

IRE National Convention, Mar. 23–26, Waldorf-Astoria Hotel & New York Coliseum, New York.

American Physical Society, Mar. 30–Apr. 1, Hotel Somerset, Boston & MIT, Cambridge, Mass.

Microwave Research Institute, Polytechnic Institute of Brooklyn, Symposium on Millimeter Waves, Mar. 31–Apr. 2, Engineering Societies Bldg., New York.

Inter-Society Color Council, 28th Annual Meeting, Apr. 1, 1959, Statler-Hilton Hotel, New York.

Optical Society of America, Apr. 2–4, Hotel New Yorker, New York.

AFOSR, Third Annual Astronautics Symposium, Apr. 6–8, Sheraton-Park Hotel, Washington, D.C.

Armour Research Foundation, 4th Conference on Industrial Instrumentation and Control, Apr. 14, 15, Ill. Inst. of Technology, Chicago.

American Physical Society, Apr. 30–May 2, Willard & Raleigh Hotels, Washington, D.C.

Electro-Chemical Society, 7th Annual Semiconductor Symposium, May 3–7, Sheraton Hotel, Philadelphia.

85th Semiannual Convention of the SMPTE including International Equipment Exhibit, May 4–8, 1959, Fontainebleau, Miami Beach.

IRE 7th Region Technical Conference and Trade Show, May 6–8, Univ. of New Mexico, Albuquerque, N.M.

Acoustical Society of America, May 14–16, Ottawa, Ont.

IEE, Transistors and Associated Semiconductor Devices, International Convention, May 21–27, Earls Court, London.

American Rocket Society, June 8–11, San Diego, Calif.

International Conference on Information Processing, June 13–22, Unesco, Paris, France.

International Commission on Illumination, 14th Congress, June 15–24, Brussels, Belgium.

International Symposium on Circuit and Information Theory, June 16–18, Univ. of Calif., Los Angeles.

Engineering Progress Exposition, June 17–20, Hotel Commodore, New York.

American Physical Society, June 18–20, Milwaukee, Wis.

American Society for Testing Materials, Annual Meeting, June 21–26, Chalfont-Haddon Hall, Atlantic City, N.J.

86th Semiannual Convention of the SMPTE including Equipment Exhibit, Oct. 5–9, Statler, New York.

87th Semiannual Convention of the SMPTE, May 1–7, 1960, Ambassador Hotel, Los Angeles.

88th Semiannual Convention of the SMPTE, Oct. 16–22, 1960, Sheraton-Park Hotel, Washington, D.C.

89th Semiannual Convention of the SMPTE, Spring, 1961, Royal York, Toronto.

90th Semiannual Convention of the SMPTE, Oct. 15–20, 1961, New York.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1958 Journal, Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

Progress toward the attainment of these objectives is greatly aided by the financial support provided by the member companies listed below.

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Universal Pictures Company, Inc.
Warner Bros. Pictures, Inc.
Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
Moviola Manufacturing Co.
National Carbon Company, A Division of Union Carbide and Carbon Corporation
National Screen Service Corporation
National Theatre Supply Company
Northwest Sound Service, Inc.
Panavision Incorporated
Pathé Laboratories, Inc.
Prestoseal Mfg. Corp.
Producers Service Co.
Rank Precision Industries Ltd.
Reid H. Ray Film Industries, Inc.
Reeves Sound Studios, Inc.
Charles Ross, Inc.
S.O.S. Cinema Supply Corp.
Shelly Films Limited (Canada)
The Strong Electric Company
Technicolor Corporation
Titra Film Laboratories, Inc.
Trans-Canada Films Ltd.
Tri Art Color Corporation
Van Praag Productions
Alexander F. Victor Enterprises, Inc.
Westinghouse Electric Corporation
Westrex Corporation
Wilding Picture Productions, Inc.
Wollensak Optical Company

The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee: Byron Roudabush, c/o Byron, Inc., 1226 Wisconsin Ave., N.W., Washington 7, D.C.